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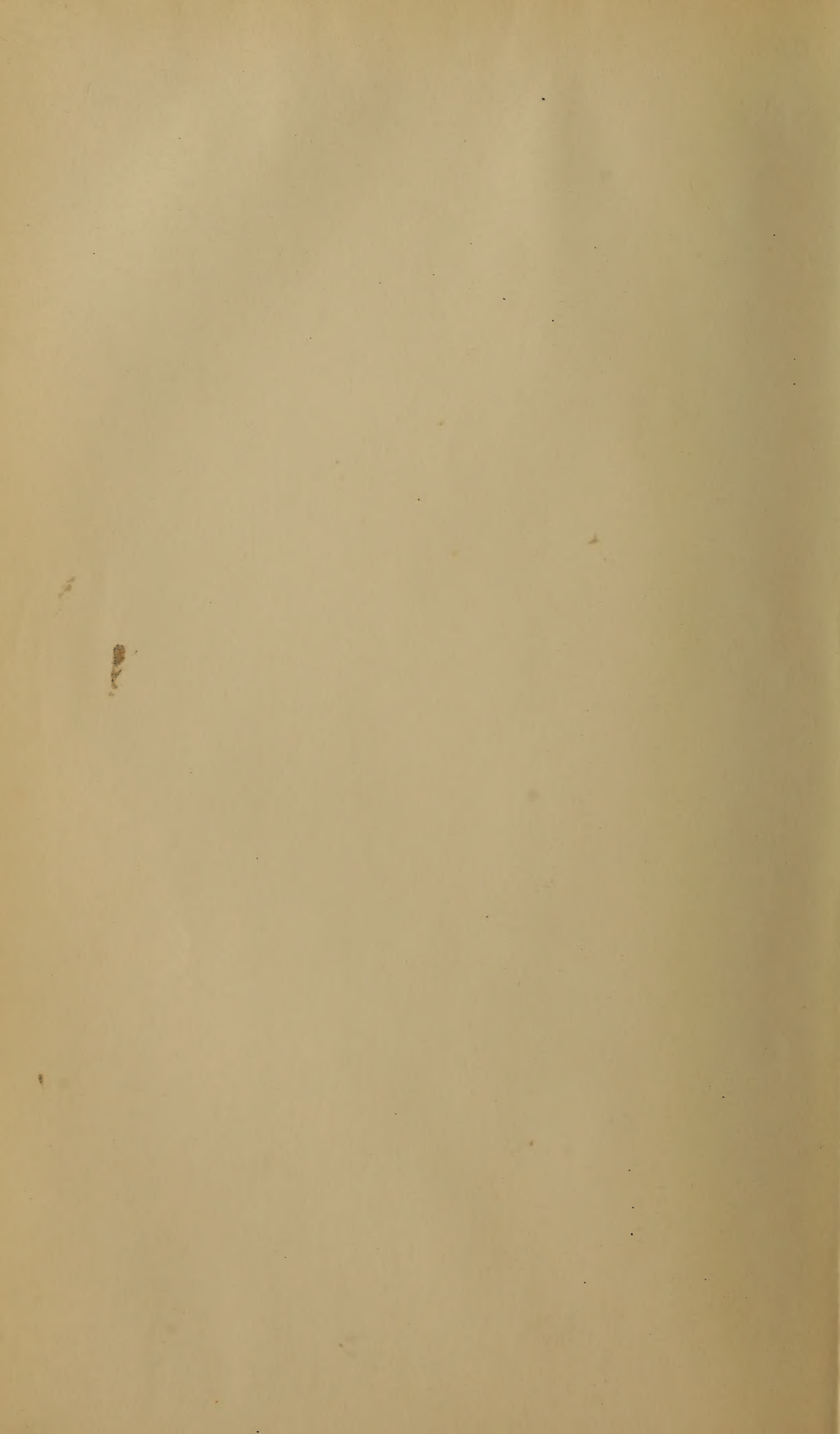
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P. 124

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Published fortnightly

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New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 178

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1914

BY

D. H. NEWLAND

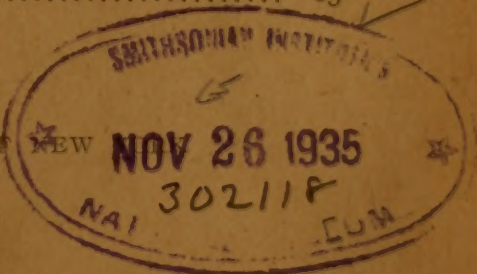
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THE UNIVERSITY OF THE STATE OF NEW

1915

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The University of the State of New York

Science Department, June 28, 1915

Dr John H. Finley

President of the University

SIR:

I beg to communicate to you herewith the manuscript of the *Mining and Quarry Industry of New York State: Report of Operations and Production During 1914*, prepared by David H. Newland, Assistant State Geologist, and to recommend its publication as a bulletin of the State Museum.

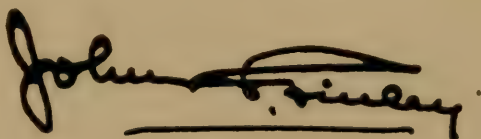
Very respectfully

JOHN M. CLARKE

Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 29th day of June 1915

A handwritten signature in dark ink, appearing to read "John H. Finley". The signature is written in a cursive style with a large initial "J" and a long horizontal stroke extending to the right.

President of the University

University of the State of New York Bulletin

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JOHN M. CLARKE, Director

Museum Bulletin 178

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1914

BY

D. H. NEWLAND

INTRODUCTION

The mineral industries experienced a decided setback last year, reversing the course they followed in the preceding twelve months which was a period of great activity. The output was smaller by nearly 15 per cent than in 1913 and during the last half of the year some branches were almost at a standstill owing to the very unsettled market and financial conditions. A number of enterprises suspended operations for a time; a few are reported to have withdrawn from business with no immediate prospect that work will be resumed. It is certain that the ground lost can not be recovered for some time and it is not unlikely that further reductions in the output of many products will be noted for the current season.

The total value of the ores and mineral materials, in the crude or first prepared forms, as reported by the individual enterprises,

was \$35,870,004, as compared with \$41,598,399 in 1913. The decline of activity during the year was really greater than indicated by this loss in value of the output, since the reaction did not assume serious proportions before the late summer and then developed rapidly to the close of the season. The situation at the end of the year was extremely unsatisfactory to the producers.

As a further index of the industrial conditions, a compilation of the tonnage of ores and minerals raised from underground workings has been made. The materials which are produced in New York wholly or mainly by mining operations in the strict sense comprise iron ores, pyrite, rock salt, gypsum, graphite and talc; the others are obtained by open-cast methods. The total quantity of such materials raised in the year was 2,587,710 tons against 3,156,643 tons in 1913 and 2,722,648 tons in 1912.

The products on which the valuations above mentioned are based number over thirty and with few exceptions represent the materials as they come from the mines and quarries without elaboration or manufacture, except so much as is necessary to put them in marketable form. They do not include secondary products like iron and steel, sulphuric acid, aluminum, carborundum, calcium carbide, artificial graphite, alkali products, etc., the manufacture of which constitutes a large industry by itself with an annual output of a much greater value than that returned by the industries covered in this report.

Iron ore is the most valuable metallic mineral found in the State and has been mined actively for 150 years. The gross output of the ore last year was 1,122,221 long tons. After deduction for shrinkage in concentration, which is practised by the Adirondack mines, there remained a total of 751,716 long tons of shipping product which had a value of \$2,356,517, as compared with 1,217,899 long tons valued at \$3,870,841 for the year 1913. This branch of mining is subject to rapid changes and the decrease does not reflect any serious complications in the industry itself. There are indications in fact that the output will soon exceed all previous records.

The clay-working industries take first rank in value of the annual production and last year returned a total of \$9,475,219 which represented a reduction of one-fifth as compared with the sum of \$12,077,872 reported in 1913. There was a large decrease in the structural materials like brick, fireproofing and terra cotta for which the demand was exceedingly poor; the potteries also reported

a smaller output, as did the makers of tile and sewer pipe. Practically the only branch that showed a gain during the year was the paving brick industry which registered an increase of 15 per cent, continuing the steady growth of the previous years.

In view of the depression that prevailed in the building trades the large increase in cement manufacture is remarkable, probably not paralleled by the industry of any other eastern state. The output of portland cement was 5,667,728 barrels, with a value at the works of \$5,088,677, a record total. Natural cement showed a small increase, the output amounting to 232,076 barrels worth \$115,117.

The stone products, including granite, limestone, marble, sandstone and trap, were valued at \$5,741,197, against \$6,763,054. All kinds showed a decrease, except granite which made a slight gain. More than one-half of the value was represented by crushed stone used in concrete and road construction. There was a notable falling off in the number of quarries under operation, and scarcely any new developments were reported.

The salt mines and evaporating works contributed a product of 10,389,072 barrels, as compared with 10,819,521 barrels in 1913. With this exception, the industry has had an almost uninterrupted record of growth in the last decade. The value of the product was but little below that of 1913, the actual figures being \$2,835,706 against \$2,856,664 in the latter year.

In the gypsum industry there was no notable change, although the output fell off slightly and amounted to 513,094 tons, against 532,884 tons in the preceding year. Most of the rock was converted at the mines into stucco and wall plasters; the remainder, about one-third, was sold crude to cement plants or ground for agricultural plaster. The value of the different products was \$1,247,404 as compared with \$1,306,143 in 1913.

The flow of natural gas in the different districts of the State amounted to 8,714,681,000 cubic feet, about 4 per cent less than in the preceding year, but the value which was reported as \$2,570,165 showed a slight gain owing to the higher prices at which the product was sold. There were no discoveries of importance to counterbalance the normal decline of the developed territory. The oil wells in Cattaraugus and Allegany counties contributed an output of 933,511 barrels, or about the same quantity as in 1913. Owing to the decline of prices from the high mark of \$2.50 a barrel which they reached in the latter year, the value of the product was considerably smaller, the total being \$1,773,671.

Among the other branches of the mineral industry that shared in the activities were those of talc, graphite, garnet, pyrite, slate, mineral paints, mineral waters, emery, feldspar, quartz, molding and building sand, sand-lime brick, marl and apatite. Talc ranks as one of the more important of these, the output amounting to 74,075 short tons valued at \$671,286. The mines are in the western Adirondack region. Garnet for abrasive uses is produced in the eastern Adirondacks, the product last year amounting to 4026 short tons, with a value of \$134,940.

Mineral production of New York in 1913

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement.....	Barrels.....	5 146 782	\$4 873 807
Natural cement.....	Barrels.....	193 975	95 565
Building brick.....	Thousands.....	1 099 861	6 038 658
Pottery.....	.....	.....	3 367 187
Other clay products.....	.....	.....	2 672 027
Crude clay.....	Short tons.....	6 291	17 411
Emery.....	Short tons.....	611	7 332
Feldspar and quartz.....	Short tons.....	25 680	113 765
Garnet.....	Short tons.....	4 665	145 445
Graphite.....	Pounds.....	2 250 000	112 500
Gypsum.....	Short tons.....	532 884	1 306 143
Iron ore.....	Long tons.....	1 217 899	3 870 841
Millstones.....	.....	.....	13 130
Metallic paint.....	Short tons.....	7 950	78 200
Slate pigment.....	Short tons.....	2 200	15 026
Mineral waters.....	Gallons.....	9 448 348	806 298
Natural gas.....	1000 cubic feet..	9 155 429	2 549 227
Petroleum.....	Barrels.....	916 873	2 255 508
Pyrite.....	Long tons.....	54 903	242 065
Salt.....	Barrels.....	10 819 521	2 856 664
Sand and gravel.....	.....	.....	2 584 266
Sand-lime brick.....	Thousands.....	22 225	143 345
Roofing slate.....	Squares.....	6 109	53 074
Slate manufactures.....	.....	.....	Nil
Granite.....	.....	.....	335 642
Limestone.....	.....	.....	3 852 678
Marble.....	.....	.....	252 292
Sandstone.....	.....	.....	1 321 272
Trap.....	.....	.....	1 001 170
Talc.....	Short tons.....	63 000	551 250
Other materials ¹.....	.....	.....	66 611
Total value.....	.....	.....	\$41 598 399

¹ Includes apatite, diatomaceous earth, marl and mica.

Mineral production of New York in 1914

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement.....	Barrels.....	5 667 728	\$5 088 677
Natural cement.....	Barrels.....	232 076	115 117
Building brick.....	Thousands.....	943 241	4 703 295
Pottery.....	.....	.....	2 405 676
Other clay products.....	.....	.....	2 366 248
Crude clay.....	Short tons.....	7 109	12 424
Emery.....	Short tons.....	7 63	9 105
Feldspar and quartz.....	Short tons.....	23 751	117 390
Garnet.....	Short tons.....	4 026	134 940
Graphite.....	Pounds.....	2 483 339	151 143
Gypsum.....	Short tons.....	513 094	1 247 404
Iron ore.....	Long tons.....	751 716	2 356 517
Millstones.....	.....	.....	12 410
Metallic paint.....	Short tons.....	7 321	88 720
Slate pigment.....	Short tons.....	1 182	9 620
Mineral waters.....	Gallons.....	8 480 669	769 932
Natural gas.....	1000 cubic feet..	8 714 681	2 570 165
Petroleum.....	Barrels.....	933 511	1 773 671
Pyrite.....	Long tons.....	61 513	266 930
Salt.....	Barrels.....	10,389 072	2 835 706
Sand and gravel.....	.....	.....	2 212 087
Sand-lime brick.....	Thousands.....	17 696	111 326
Roofing slate.....	Squares.....	4 998	40 650
Granite.....	.....	.....	367 242
Limestone.....	.....	.....	3 316 063
Marble.....	.....	.....	230 242
Sandstone.....	.....	.....	1 056 990
Trap.....	.....	.....	770 600
Talc.....	Short tons.....	74 075	671 286
Other materials ¹.....	.....	.....	58 428
Total value.....	.....	.....	\$35 870 004

¹ Includes apatite and marl.

ASBESTOS

The minerals which supply the asbestos of commerce are known to occur in several places within the State, more especially in the crystalline areas of the Adirondacks and southeastern New York. They are nowhere mined at present, but the occurrences have been at different times the object of inquiry and more or less attention which in one instance has extended to considerable exploratory work. The purpose of this article is to mention the different localities which have come to light and to give whatever information is available concerning their features and possible importance.

That the local occurrences have aroused some interest from a commercial standpoint is not surprising in view of the recent great development in the uses of asbestos and of the remarkable growth

of the Canadian mining industry which supplies the larger share of the world's needs of the material. The principal mines of Canada are situated in the province of Quebec, on the south side of the St Lawrence river, not very remote from the northern boundary of New York. The district in fact extends southward across the Vermont line, in which state there are similar occurrences which have more or less importance.

The proximity of the Adirondack crystalline region to that district might be regarded as favorable to its carrying the same kind of deposits, but there is really no basis for such inference as a little consideration will show. The asbestos of Canada and Vermont is found within a belt of metamorphosed Paleozoic formations which lie along the flanks of the Green Mountain uplift. The particular home of the mineral is in serpentine, in this case the product of alteration of old igneous rocks originally composed of minerals of the olivine and pyroxene groups. A large number of serpentine bodies are known in the stretch from southern Vermont into and across the eastern townships of Quebec, but in only a few is asbestos present in workable proportions. The mines or quarries are based on masses of serpentine that carry closely crowded veinlets of chrysotile, the latter occurring in such profusion as to permit the excavation of the whole mass, from which the fiber is then obtained by hand picking or by milling operations.

No similar bodies of serpentine are found in the Adirondacks. The latest igneous intrusions in that region took place before the opening of the Cambrian period, and the sedimentary formations were laid down at a much earlier date. The igneous intrusions did not include any rocks of the peridotite class (composed of olivine) and consequently there has been no material from which large serpentine masses could develop. The occurrence of serpentine and of chrysotile is limited to the crystalline limestones which are found in belts and in which the serpentine is disseminated in nodules, bands and small particles in the midst of the carbonate minerals. The proportion of serpentine to the whole rock is variable; in some places it may constitute the greater part but usually it plays a subordinate role, being one of several impurities of the limestones. It is a secondary product, formed in most cases by the alteration of a pyroxene mineral. The asbestos is a variety of the serpentine that occurs in small veins, rounded aggregates and irregular patches. It is apt to be very irregular in its occurrence, but is sometimes rather abundant within limited areas of

the limestones. The fiber looks like the commercial fiber of Canada and Vermont but seems to be of lighter color and greater transparency. From the features of its development it is regarded as a vein mineral, deposited in cracks and cavities, by solutions circulating through the limestones and probably derived from the disseminated serpentine which, as stated, is an alteration of pyroxene.

Serpentinous limestones are not at all rare in the Adirondacks; in fact they are rather common in the eastern part in Essex and Warren counties and also in the northwest in St Lawrence county. They are associated with the normal crystalline limestones, of which they are only a special development, the serpentine itself having no geological significance. In some places the rock has been quarried as an ornamental stone, since the greenish serpentine particles with the white or bluish dolomite base give a very pleasing effect that makes the stone suitable for interior decorative work. Some of the better known localities for these serpentinous marbles are just north of Port Henry on Lake Champlain, in western Moriah township, near Minerva and Olmstedville, all in Essex county, and in the town of Thurman, Warren county.

Wherever the serpentinous limestones are found asbestos may be expected in greater or lesser amount, though of course as a subordinate constituent.

The principal occurrence of this nature that has thus far been uncovered is in the town of Thurman, about 7 miles west of Thurman station on the Adirondack branch of the Delaware & Hudson Railroad. There is a large area of crystalline limestone which here and there contains bands charged with serpentine occurring as rounded and irregular patches of some size but irregularly distributed and as small grains that are more evenly scattered through the mass. Such a band was prospected a few years ago, resulting in the production of a small quantity of chrysotile or serpentine asbestos. The latter occurs principally within a small but rather persistent zone of the limestone that takes a northeasterly course parallel to the general structural trend. Within this zone occur numerous veinlets that carry a very light, silky asbestos of a maximum length of about an inch, most of which is apparently of good quality. The veins are not persistent, but thin quickly and merge into the massive serpentine of the country rock. Outside the main zone, bunches of serpentine are to be seen which are shot through with fiber, or show the presence of whitish asbestiform material. The general average of the fiber is probably not more than one-

fourth of an inch. Samples were shipped by the owner of the property to asbestos manufacturers who reported favorably upon its quality. Although a part of the rock, no doubt, is of workable grade, not a very large quantity of that kind has as yet been exposed in the workings.

A small prospect showing serpentine asbestos of fairly long fiber was seen by the writer some years ago on the north side of Brant lake, in the town of Horicon, Warren county. It is not known by whom the property was explored, but apparently the results did not warrant a continuance of the work.

Serpentinous limestones are also found in the Highlands region in Putnam and Orange counties; from the locality in Philipstown east of Cold Spring many samples of chrysolite have been gathered for museums. Mather in the New York Geological Reports for 1839 mentions an occurrence at Cotton rock in the same town on the bank of the Hudson, $3\frac{1}{2}$ miles below West Point.

On Staten Island and near the village of Rye, Westchester county, are bosses of serpentine which furnish the closest parallels to the Canadian and Vermont occurrences. The Staten Island boss has a surface of about 15 square miles and constitutes the central elevated part of the island. The rock is apparently an igneous derivative, as unaltered remnants of olivine and pyroxene have been discovered in it. Both amphibole and serpentine asbestos occur within the area, the former variety being restricted to the border where the serpentine is in contact with schistose rocks belonging to the Manhattan formation. Examples of amphibole asbestos have been collected from Pavilion hill near Tompkinsville and at Fort George; one specimen found by the writer near the latter place possessed fibers nearly a foot long. Chrysotile is less common, but a few years ago was still to be found on Pavilion hill.

CEMENT

The cement manufacturers had a rather poor season in 1914. The year opened auspiciously, with the demand large enough to keep the mills operating at full capacity and prices on the same basis as in the preceding year, which was regarded as reasonable from the standpoint of both consumer and manufacturer. These conditions, however, did not hold out, as the demand began to slacken before many months had elapsed and showed a declining tendency throughout the latter half of the year. In the last four months the market broke badly under the load of accumulated

stocks which were sold at considerable concessions from the price basis that had obtained during the early part of the year. At the close it appeared that the industry would soon lose all the ground it had been able to gain during the period of relative prosperity which followed four or five years of almost unrelieved depression for the local plants.

The mills for the most part operated throughout the year at their average capacity, so that the market conditions were not reflected in the production returns, although a reduction may be looked for during the current season unless the market shows great improvement. There was a large surplus of cement carried over into the new year.

In the first part of 1914 the general average of portland cement prices was the same as obtained during the preceding year, that is, around 95 cents for standard brands. This quotation was for deliveries at the mill, not including cost of package. The New York City basis was \$1.18 in bulk and \$1.58 in package. The mills within the State received somewhat better prices in the local markets. Before the close of the year cement was selling in New York City at 20 and 25 cents below these quotations with large offerings. The average price received by the mills for the whole year was about 90 cents a barrel as compared with 95 cents in 1913 and 78 cents in 1912.

Conditions in the natural cement trade were practically unchanged, the present industry contributing only a small part of the total output, although a few years ago it was the principal branch.

The reports, which have been received from all the cement manufacturers within the State, show that the total output last year amounted to 5,899,804 barrels. In the preceding year the combined production of portland and natural cement was 5,340,757 barrels and in 1912 it was 4,783,535 barrels. The steady growth of the portland cement industry in the last few years has raised the production now to a higher rate than prevailed at the time of the highest prosperity of the natural cement trade.

The output of portland cement for 1914 was 5,667,728 barrels. In the preceding year it amounted to 5,146,782 barrels, showing a gain of about 10 per cent for this branch of the industry. The value of the production based on the average selling prices for the year was \$5,088,677, or at the rate of approximately 90 cents a barrel. There were eight mills in operation, the same number as in 1913.

The natural cement mills contributed an output of 232,076 barrels, against 193,975 barrels in 1913. The value of the product was \$115,117 or about 50 cents a barrel at the mill. Most of this cement was made in the Rosendale district of Ulster county by a single manufacturer, but small amounts were contributed by three plants in Onondaga county.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1895.....	59 320	\$278 810	3 939 727	\$2 285 094
1896.....	260 787	443 175	4 181 918	2 423 891
1897.....	394 398	690 179	4 259 186	2 123 771
1898.....	554 358	970 126	4 157 917	2 065 658
1899.....	472 386	708 579	4 689 167	2 813 500
1900.....	465 832	582 290	3 409 085	2 045 451
1901.....	617 228	617 228	2 234 131	1 117 066
1902.....	1 156 807	1 521 553	3 577 340	2 135 036
1903.....	1 602 946	2 031 310	2 417 137	1 510 529
1904.....	1 377 302	1 245 778	1 881 630	1 207 883
1905.....	2 117 822	2 046 864	2 257 698	1 590 689
1906.....	2 423 374	2 766 488	1 691 565	1 184 211
1907.....	2 108 450	2 214 090	1 137 279	757 730
1908.....	1 988 874	1 813 622	623 588	441 136
1909.....	2 061 019	1 761 297	549 364	361 605
1910.....	3 364 255	2 939 818	292 760	147 202
1911.....	3 416 400	2 930 434	274 973	134 900
1912.....	4 495 842	3 488 931	287 693	142 165
1913.....	5 146 782	4 873 807	193 975	95 565
1914.....	5 667 728	5 088 677	232 076	115 117

It is quite probable that the production of portland cement will soon be over 6,000,000 barrels a year. Additional capacity is now being provided in the plant of the Millen Portland Cement Co. at Jamesville, which began operations in 1913. The company will install a second kiln of the same capacity as the original one, which was rated at 700 barrels a day. The mill of the Cayuga Lake Cement Co., according to current reports, will also be enlarged. A few years ago the Seaboard Portland Cement Co. erected a plant below Catskill on the Hudson river, but never placed it in operation. It has now been taken over by the Acme Cement Co., which has made extensive changes and improvements with the view to entering upon active operations during the present season.

CLAY

BY ROBERT W. JONES

Due to the decrease in building construction during the year 1914 the production of clay products, along with other building materials, fell off considerably from that of the preceding season. In four of the principal cities of the State that depend largely upon local materials for building purposes, the falling off in construction during 1914 as compared with 1913 amounted to an average of 22.1 per cent. In New York City alone, building construction fell off 16.8 per cent.

The following table gives the production of clay materials in the State during the last three years:

Production of clay materials

MATERIAL	1912	1913	1914
Common brick.....	\$6 666 945	\$5 938 922	\$4 597 856
Front brick.....	109 657	99 736	105 439
Vitrified paving brick.....	382 984	576 970	680 226
Hollow brick.....	42 575	44 265	38 119
Fireproofing.....	230 833	276 053	245 034
Terra cotta.....	1 139 291	1 113 322	892 630
Fire brick and stove lining....	380 005	371 408	331 671
Drain tile.....	122 571	134 199	92 938
Sewer pipe.....	77 644	154 646	81 000
Pottery.....	2 876 762	3 367 187	2 405 676
Miscellaneous.....	13 828	1 164	4 630
Total.....	\$12 043 095	\$12 077 872	\$9 475 219

One hundred ninety companies or individuals were active during the year as compared with 204 during the season of 1913. One hundred thirty-three reported a production of common soft-mud building and 13 a production of wire-cut building brick, or all together 145 as compared with 159 for the preceding year. The aggregate number of common building brick manufactured during the season amounted to 932,759,000 as compared with 1,090,506,000 for 1913; their value was \$4,597,856 against \$5,938,922 for 1913. Of the number of common building brick produced, 55,071,000 were made by the stiff-mud, wire-cut process with a value of \$365,159 as compared with a value of \$424,894 during 1913. All clay products, with the exception of vitrified paving brick, fell off in value. Paving brick made an increase of 15.1 per cent in value and 23 per cent in quantity over 1913.

Thirty-five counties reported a production of clay products; of this number, 34 had a production of common building brick. Onondaga county held first place in the industry with a production of \$1,556,093. The other leading counties were Ulster with a value of \$895,126; Erie with \$819,427 and Rockland with \$747,026. The only counties that reported increases in production were Cattaraugus, Cayuga, Chautauqua and Westchester.

Production of clay materials by counties

COUNTY	1912	1913	1914
Albany.....	\$457 694	\$473 325	\$369 312
Allegany.....	a.....	.....	.....
Broome.....	.....	a.....	a.....
Cattaraugus.....	231 156	275 763	334 557
Cayuga.....	3 740	5 800	8 765
Chautauqua.....	113 315	147 451	168 134
Chemung.....	79 510	a.....	a.....
Clinton.....	.....	a.....	a.....
Columbia.....	381 888	307 571	198 866
Dutchess.....	665 082	634 043	430 269
Erie.....	810 516	1 000 055	819 427
Greene.....	202 306	290 116	196 889
Jefferson.....	3 630	.....	.....
Kings.....	574 805	539 002	449 839
Livingston.....	125 642	200 248	73 775
Monroe.....	246 264	278 145	168 463
Montgomery.....	14 400	a.....	a.....
Nassau.....	119 708	109 051	96 534
New York.....	56 884	a.....	.....
Niagara.....	22 357	55 469	38 213
Oneida.....	85 897	84 714	45 000
Onondaga.....	1 368 345	1 613 395	1 556 093
Ontario.....	341 617	470 638	68 762
Orange.....	615 155	472 465	319 500
Queens.....	613 605	651 328	472 616
Rensselaer.....	169 179	151 202	124 152
Richmond.....	723 875	588 534	454 646
Rockland.....	994 967	820 475	747 026
St Lawrence.....	.....	a.....	a.....
Saratoga.....	516 632	460 223	255 562
Schenectady.....	539 928	579 158	354 872
Steuben.....	181 663	a.....	a.....
Suffolk.....	92 150	81 000	69 300
Tompkins.....	.....	.....	a.....
Ulster.....	1 296 779	1 077 655	895 126
Warren.....	17 875	a.....	a.....
Washington.....	19 620	14 625	10 186
Wayne.....	a.....	a.....	.....
Westchester.....	344 798	290 256	321 826
Other counties <i>b</i>	12 113	406 165	427 509
Total.....	\$12 043 095	\$12 077 872	\$9 475 219

a Included under other counties.

b In 1912, aside from counties marked *a*, are Clinton, St Lawrence, Tompkins and Wayne counties. In 1913 and 1914 are included counties marked *a*.

COMMON BUILDING BRICK

The State can be conveniently divided into five common-brick manufacturing districts, according to the materials and methods of manufacture. The first and most important is the Hudson river tidewater region extending from Croton Point on the south to and including Rensselaer and Albany counties on the north. The entire output of this region, with the exception of a small quantity produced in Albany and Rensselaer counties, is disposed of in the metropolitan district that includes New York, Jersey City and environs. The total product of this section during the season of 1914 was 709,877,000 brick with a value of \$3,346,430 as compared with 788,731,000 and a value of \$4,176,406 for 1913. This section consists of five main producing areas, with some outlying yards. The next important section of the State is farther north in the Hudson valley around Mechanicville; this district reported a total of 50,416,000 brick with a value of \$240,912 as compared with a production of 89,744,000 for 1913. Nearly the entire output of this section is sold in the New England markets. Another important section is Long Island and Staten Island whose product is disposed of in the southern New England states and in the local markets. The output for the past season was 57,735,000 brick valued at \$276,832 as compared with 59,004,000 and a value of \$331,071 for 1913. Erie county is the other district with a production of 40,015,000 valued at \$244,116 as compared with 56,899,000 and a value of \$380,153 for 1913.

Production of common building brick by counties

COUNTY	1913		1914	
	Number	Value	Number	Value
Albany.....	66 700 000	\$370 425	58 625 000	\$301 512
Broome.....	<i>a</i>	<i>a</i>.....	.....	.....
Cattaraugus.....	800 000	8 000	<i>a</i>	<i>a</i>
Cayuga.....	800 000	4 800	820 000	4 740
Chautauqua.....	5 352 000	35 962	3 740 000	34 726
Chemung.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Clinton.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Columbia.....	58 585 000	307 571	44 705 000	198 866
Dutchess.....	120 770 000	634 043	91 580 000	430 269
Erie.....	56 899 000	380 153	40 015 000	244 116
Greene.....	26 976 000	143 466	25 604 000	123 475
Livingston.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Monroe.....	19 747 000	99 064	11 330 000	63 650
Montgomery.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Nassau.....	15 997 000	102 531	15 352 000	88 300
Niagara.....	8 067 000	55 469	<i>a</i>	<i>a</i>
Oneida.....	11 860 000	78 088	6 450 000	43 000
Onondaga.....	19 800 000	139 150	21 800 000	147 250
Ontario.....	2 000 000	16 000	<i>a</i>	<i>a</i>
Orange.....	96 493 000	472 465	75 500 000	319 500
Rensselaer.....	12 600 000	75 550	5 025 000	28 000
Richmond.....	29 507 000	147 540	29 583 000	119 232
Rockland.....	156 281 000	820 475	150 183 000	747 026
St Lawrence.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Saratoga.....	91 745 000	458 723	51 916 000	248 412
Steuben.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Suffolk.....	13 500 000	81 000	12 800 000	69 300
Tompkins.....	.....	.....	<i>a</i>	<i>a</i>
Ulster.....	197 801 000	1 077 655	202 366 000	895 126
Warren.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Washington.....	<i>a</i>	<i>a</i>	<i>a</i>	<i>a</i>
Westchester.....	52 525 000	275 756	56 289 000	302 656
Other counties <i>b</i> ..	25 701 000	158 036	29 076 000	188 700
Total.....	1 090 506 000	\$5 938 922	932 759 000	\$4 597 856

a Included under other counties.*b* Includes in 1913 and 1914 all counties marked *a*.

Hudson River region. The decrease in building operations in the territory tributary to this district naturally affected the manufacture of brick, which showed a further decline from the very low mark registered in the preceding year. It is estimated that about 350,000,000 brick were carried over into the 1914 season, a quantity much larger than had remained on hand in the few preceding years, so that the producers started with a considerable handicap. The stock was more than sufficient to meet the needs

of the market before the new product began to be shipped, and consequently the conditions rapidly became worse when the yards got under way. Those manufacturers who depended on the first sales to finance their summer operations had to dispose of their shipments on any terms. In the case of the leased yards the prices received were below the actual cost of production. Some manufacturers, as a consequence, ceased operations as quickly as they could, and were out of business the rest of the season. No substantial change for the better occurred as the season advanced and the market held at about the same level throughout the year. The average price received for the entire sales of the year in the region was \$4.77 a thousand as compared with \$5.37 a thousand in 1913, showing a falling off of 11.2 per cent. This was the lowest average reported since 1910. The prices are for the brick at the yards, and not the New York quotations which average about \$1.25 a thousand higher, the difference representing the cost of transportation and commission exacted by the selling agents.

Output of common brick in the Hudson River region in 1913

COUNTY	NUMBER OF OPERATORS	OUTPUT	VALUE	AVERAGE PRICE A THOUSAND
Albany.....	12	66 700 000	\$370 425	\$5 55
Columbia.....	5	58 585 000	307 571	5 25
Dutchess.....	18	120 770 000	634 043	5 25
Greene.....	7	26 976 000	143 466	5 32
Orange.....	8	96 493 000	472 465	5 00
Rensselaer.....	4	12 600 000	74 550	5 97
Rockland.....	21	156 281 000	820 475	5 25
Ulster.....	24	197 801 000	1 077 655	5 50
Westchester.....	7	52 525 000	275 756	5 24
Total.....	106	788 731 000	\$4 176 406	\$5 37

Output of common brick in the Hudson River region in 1914

COUNTY	NUMBER OF OPERATORS	OUTPUT	VALUE	AVERAGE PRICE A THOUSAND
Albany.....	11	58 625 000	\$301 512	\$5 14
Columbia.....	5	44 705 000	198 866	4 45
Dutchess.....	14	91 580 000	430 269	4 69
Greene.....	5	25 604 000	123 475	4 82
Orange.....	6	75 500 000	319 500	4 23
Rensselaer.....	2	5 025 000	28 000	5 57
Rockland.....	25	150 183 000	747 026	4 30
Ulster.....	23	202 366 000	895 126	4 42
Westchester.....	7	56 289 000	302 656	5 37
Total.....	98	709 877 000	\$3 346 430	\$4 77

The output of the region was contributed by 98 firms, as compared with 106 in 1913, the smallest number at any time within the last decade. The average for each operator was also lower than in any recent year.

The yards that ship by water have a total machine capacity of about 11,000,000 brick a day, which represents the outturn of about 500 soft-mud machines. The principal districts include Haverstraw, Kingston and Dutchess Junction, but there are one or more yards at a number of other places.

The Haverstraw district includes the section along the river front from the southern limits of Haverstraw north through Grassy Point and North Haverstraw, a distance of about 3 miles, and embraces all the producers in Rockland county. It has the largest capacity of any district, the rated machine capacity being about 2,950,000 a day. There are 26 different yards, of which 25 were in operation last year. The output was 150,183,000 brick, worth \$747,026, which was only a little less than in 1913. Most of the yards in the district are worked under lease, a fixed royalty being paid for each thousand of green brick made. Four yards get their clay from the river bottom by dredges, while the others have pits or banks back of their plants.

The Kingston district extends along the river for a distance of about 12 miles, including the yards at Port Ewen, East Kingston, Glasco, Saugerties and Malden. The number of operators last year was 22, and the output amounted to 199,366,000 valued at \$878,626, or about the same number as in 1913. The total production of Ulster county was 202,366,000 valued at

\$895,126. The available machine capacity is 2,900,000 a day. The yards in this district are mostly open and hand labor is used largely in excavating and tempering the clay. One company uses clay dredged from the river bed.

The yards around Dutchess Junction, Dutchess county, reported a total product of 88,580,000 brick worth \$410,769. The corresponding figures for 1913 were 112,723,000 with a value of \$591,796. The output of the whole county amounted to 91,580,000 valued at \$430,269. The number of operators in the district was 13 and in the county 14, as compared with 16 and 18 respectively in 1913. The yards of the district have an available capacity of 1,936,000 brick a day, but not all were active.

In Westchester county seven producers reported an output of 56,289,000 worth \$302,656, against 52,525,000 worth \$275,756 in the preceding year. Most of the yards are situated along the river between Croton Point and Verplanck Point, where a machine capacity of 1,122,000 is available. A large part of the output is marketed within the county which contains a number of thriving cities and communities, so that the prices are apt to vary considerably from the New York quotations, the average in most years being higher.

Of the output of Albany county, which amounted last year to 58,625,000 valued at \$301,512, a little less than one-half was sold locally and the remainder shipped to the lower Hudson markets. The yards that manufacture brick for shipment are situated at Coeymans, while the others are located at Cohoes, Watervliet and Albany.

Rensselaer county usually does not ship any brick, the output being consumed in Troy and vicinity. Only two operators reported as active last year, against four in 1913, and their output was 5,025,000 valued at \$28,000. The average selling price was the highest of any of the Hudson river counties, \$5.57 a thousand.

FRONT BRICK

The output of front brick includes different grades. The red and buff brick are simply selected common brick made by the stiff-mud process under the same conditions as those obtaining in the manufacture of the common variety. Greater care, however, is exercised in the burning and the product is carefully sorted as to color. The buff brick are made only in Richmond county. Rough-faced tapestry brick are made by the shale brick yards which also produce paving brick. They are burned in the same kilns with

the latter, occupying from two to six courses at the bottom where the temperature does not rise high enough for the thorough vitrification required in pavers. The roughened surface is secured by means of a wire placed near the die of the press so that it drags over the surface of the clay ribbon as this comes from the machine. Another class of front brick consists of dry-pressed brick. The production in 1914 consisted of 3,000,000 red smooth-faced brick valued at \$30,000, 4,151,000 rough-faced brick valued at \$39,205 and 3,331,000 dry-pressed brick valued at \$36,234, aggregating altogether 10,482,000 valued at \$105,439. In 1913 the output was 9,355,000 valued at \$99,736.

COMMON HOLLOW BRICK

There were seven producers of common hollow brick last year who reported an output of 6,402,000 with a value of \$38,119, as compared with nine producers in the preceding year with a reported outturn of 7,631,000 worth \$44,265. Common hollow brick are made by the same methods as those used for hollow building blocks. Both clays and shales are employed and the molding is by the stiff-mud process, the brick being end cut. There are two forms—headers and stretchers. They are used chiefly for the construction of an inside course upon common building brick or fireproofing. The output is consumed in the larger cities.

FIREPROOFING

Fireproofing was made by seven companies, the same number as in 1913, who reported an output valued at \$245,034. The total for the preceding year was \$276,053. The material classed as fireproofing is reported under the names of terra cotta lumber, fireproofing, hollow tile and hollow building block. It includes many different shapes and sizes that are used in the construction of side-walls, floors, arches and partitions, but not common hollow brick, which latter are used for veneering and not in the main construction. It is made by the stiff-mud process out of clays or shales, or a mixture of the two, according to the local conditions, and is burned in round downdraft kilns. The market for the material has increased steadily, with the exception of the past year when all building operations were greatly curtailed.

PAVING BRICK

A large gain in the production of paving brick was reported last year, this industry furnishing one of the few exceptions to the general record of depression. The number made was 46,696,000,

an increase of about 30 per cent for the year, and the largest output in the history of the industry. The demand for paving brick has developed rapidly with the growing recognition that they are one of the few materials which will withstand the hard usage of modern street traffic. In the last few years particularly they have come into general favor and are now being utilized for the rebuilding of many highways throughout the State. In the year 1914 a total of 49,374,169 paving brick were laid on State roads, or more than the local production. Most of the output of the local yards was shipped outside, less than one-fourth being used within the State. The production of paving brick in the last decade is given in the accompanying table.

Production of paving brick in New York

YEAR	QUANTITY	VALUE	VALUE A THOUSAND	NUMBER OF PLANTS
1905.....	13 984 000	\$180 004	\$12 87	6
1906.....	11 472 000	178 011	15 51	5
1907.....	12 296 000	184 306	14 98	4
1908.....	14 570 000	211 289	14 50	5
1909.....	12 278 000	207 970	16 27	3
1910.....	19 762 000	333 511	16 88	4
1911.....	23 993 000	388 479	16 19	4
1912.....	18 249 000	382 984	15 78	5
1913.....	35 666 000	576 970	16 17	6
1914.....	46 696 000	680 226	14 56	6

TERRA COTTA

The production of terra cotta is carried on by several plants in the southern part of the State. The materials used are brought in from New Jersey, with the exception of some clays used in glazing. The output in 1914 had a value of \$892,630, which as compared with the value of \$1,113,322 reported in the preceding year, represented a decline of 10 per cent. The unsettled business conditions accounted for the decline.

DRAIN TILE

The entire output for the year had a value of \$92,938 and was produced by fourteen firms operating in Albany, Cayuga, Erie, Monroe, Oneida, Onondaga, Ontario, Saratoga, and Washington counties. The falling off from the preceding year when the pro-

duction had a value of \$134,199 was due mostly to the reorganization and temporary closing of a few plants whose entire output was sold to the export trade. The remaining production chiefly sold for local consumption remained in about the same condition.

POTTERY

For the first time in many years the pottery industry showed a decided falling off in activity and interrupted the steady gain which has marked the course of production. The decrease amounted to nearly 30 per cent, mainly affecting the electrical porcelain business. The table below gives the value of the production for the last three years.

Value of production of pottery

WARE	1912	1913	1914
Stoneware.....	\$46 024	\$37 077	\$28 888
Red earthenware.....	29 697	35 790	31 806
Porcelain and semiporcelain.....	1 038 428	1 143 835	1 129 629
Electric and sanitary supplies.....	1 727 553	2 100 985	1 187 506
Miscellaneous.....	35 060	49 500	27 847
Total.....	\$2 876 762	\$3 367 187	\$2 405 676

CRUDE CLAY

Four counties reported a production of crude clays. The greater portion of this output was sold under the name of slip clay and was used mainly in the manufacture of porcelain electric insulators, although a small amount was produced for use in the manufacture of decorative terra cotta and for bonding purposes. Onondaga county produced some red burning clays for use in the manufacture of red ware. Richmond county made the only production of a white or light burning clay. The total production of crude clays amounted to 7109 tons having a value of \$12,424. Of this amount, 4,703 tons with a value of \$10,407 were slip clays.

At present slip clays are used mainly in the production of glazes for porcelain electric insulators, and therefore have to be of such quality that they will fuse at a comparatively low temperature and in a quiet manner and yield a glaze that will be able to stand up under the extreme condition of a very high voltage current. Such

clays have been reported from only a few localities, the largest deposits being found in the Hudson valley. The clay beds of this area cover a section extending along both banks of the river for a distance of about 40 miles south of the city of Troy. Not all the clays in the area are slip clays.

The clays found in the Hudson valley were deposited in the waters of Lake Albany, a glacial lake which at one time occupied a section of the valley from Rhinecliff north to the Battenkill. The clays are underlain mostly by soft gray and black shales and sandstones of Ordovician age. The grinding action of the ice reduced the surface portions of the shales to a very fine condition and the material then was carried by the waters from the melting glacier into the lake where they were deposited to form beds of clay more or less free from sand and gravel. The sediments deposited in the lower section of the valley and from Troy north carry a larger quantity of sand and also are considerably higher in alumina than those in the middle section where the sediments were deposited in the more quiet waters of the lake. The clays later were subjected to the action of circulating waters which lowered the percentage of calcium, magnesium, sodium and potassium in the surface layers and resulted in the formation of a brown or yellow clay that reaches an extreme thickness of 40 or 50 feet. The line between the yellow and unaltered blue clay is very sharp. In one or two localities the beds of yellow or brown clay are absent, the section consisting of from 4 to 10 feet of bluish fine-grained sand usually underlying a bed of yellow medium-grained sand. This bluish sand is so finely comminuted that 95 per cent will pass a 100-mesh screen. The sand grains retained on the 40-mesh and 60-mesh screens consist of angular fragments of limestone with a few scattered grains of clear quartz. Those retained on the 80-mesh and 100-mesh consist almost entirely of colorless or iron-stained grains of quartz with a few scattered grains of limestone and undecomposed shale or slate. Following these sand layers there is an average of 20 feet of alternating thin layers of fine-grained blue or purple plastic clay and very thin layers of blue or gray sand. Below this comes the true slip clay. This consists of beds of blue very plastic clay alternating with thin layers of sand. In other places the successions from the surface is fine sand, yellow clay and blue clay. The lower layers of the slip clay are sometimes found with a thickness of as much as 6 feet, free from sand. The chemical change due to circulating waters has in no case reached a greater depth than the

middle of the upper thin layers of the slip clay. At the junction of the yellow and blue clays there is usually found a layer of concretions consisting mostly of calcium carbonate.

The ordinary blue clays are usually very plastic and require about 29 per cent water in order to place them in condition for proper working when used in the manufacture of soft-mud brick. The air shrinkage is about 6 per cent, and when burned at cone 1 (about 1150°C) there is no fire shrinkage. The burned product is of a pink color and is usually comparatively soft. The brown clays require about 26 per cent water for proper working and have an air shrinkage of 7.5 per cent. Burned at 1150°C there is a fire shrinkage of 1.5 per cent, giving a very red, dense vitreous product.

The slip clays are produced mainly in the vicinity of Albany. No attempt has been made to open pits or banks on an extensive scale, and no method of artificial drying is attempted by those engaged in the slip clay trade exclusively. The clays are shoveled from the banks, placed on racks to be dried by the heat of the sun and then drawn to the railroad siding and loaded.

Chemical analysis of the slip clays shows that there is considerable variation in the percentages of the ingredients but that the alumina is usually low, considerably below that present in the brick clays. The following analyses illustrate the composition of the slip clays of the Hudson valley.

	1	2	3	4	5
SiO ₃	59.04	58.44	60.76	57.64	59.68
Al ₂ O ₃	11.80	15.65	12.00	15.29	14.16
Fe ₂ O ₃	5.56	3.43	2.50	2.20	1.76
TiO ₂	1.00	.90	1.10	.95	.90
CaO.....	7.81	7.02	7.12	6.70	6.68
MgO.....	3.00	5.18	4.40	4.98	4.84
K ₂ O.....	2.29	2.28	2.73	2.75	2.75
Na ₂ O.....	.53	.29	.49	.41	.40
Moisture.....	.93	.75	.64	1.45	.65
Ignition .....	.....	6.59	7.92	7.73	7.75
Total.....	.....	100.53	99.66	100.10	99.57

1 Slip clay from Albany, upper banded layers.

2 Slip clay from Albany, upper banded layers.

3 Slip clay from Albany, lower massive beds.

4 Slip clay from Albany, lower massive beds.

5 Slip clay from Albany, average sample of bank.

FELDSPAR

The production of feldspar for the various uses which it serves has been carried on in New York for many years. The industry, however, is comparatively small, embracing four or five active quarries with a combined output that has ranged recently from 10,000 to 25,000 tons a year. There is evidently an increasing demand for the material which, in view of the abundant local supplies and their favorable situation with respect to the principal markets, should bring the industry into greater prominence. A detailed description of the feldspar deposits, both developed and undeveloped, has been prepared recently by the writer and will be included as a separate chapter in a report on the quarry materials of New York now in press.

The sources of feldspar are the pegmatite bodies which accompany the crystalline formations of the Adirondacks and the southeastern Highlands. The pegmatites are abnormally coarse-grained granites, consisting of feldspar, quartz and mica, with minor amounts of other minerals, some of which are peculiar to this association. They occur in rather limited bodies which assume the shape of dikes, lenses or small bosses, intrusive in the surrounding formations, and represent offshoots from a granite magma which may or may not outcrop in the vicinity. The coarse grain of pegmatite is its most apparent characteristic, for the different ingredients assume dimensions many times larger than those characteristic of ordinary granite, the feldspar being in crystals or masses that range up to several feet in diameter and the quartz and mica in proportionately large individuals. As a consequence, the separation of the minerals can be effected usually without much difficulty by means of hand cobbing in the quarry.

The products of the pegmatite quarries include feldspar, quartz and mica which are marketed separately, and unsorted crushed pegmatite which recently has come into demand for various purposes. The feldspar may belong to one of several varieties, such as orthoclase and microcline which contain potash, or albite and oligoclase which belong to the soda-lime series. The composition of the mineral determines to some extent the uses that may be made of it and should be investigated, therefore, before any deposit is developed for quarry purposes. The potash varieties are the ones used for pottery, for which purpose they are also required to be free of iron and fairly free of intergrowth with quartz. Albite is valuable for the glazing of building tile and terra cotta;

manufacturers of these materials show a preference for it over potash spar owing to its lower fusing point.

The unsorted pegmatite which is a mixture of feldspar, quartz and mica in varying proportions is employed in making prepared roofing, in the manufacture of artificial stone, for concrete, poultry grit and other purposes. Artificial stone differs from ordinary concrete in that an attempt is made by the use of selected aggregates to render the product attractive to the eye and to imitate more or less closely natural stone.

The quartz of pegmatites may have value when it is present in such form that it is readily separable from the feldspar. It is an important product, for example, at the Kinkel quarries near Bedford. Mica is produced in minor quantities from the pegmatites that are worked for feldspar.

The quantity of feldspar and unsorted pegmatite produced last year by the New York quarries was 18,487 short tons valued at \$97,192. This was a little below the output for the preceding year, which was reported as 19,680 tons valued at \$99,765. The greatest output in any single year was in 1912 when it amounted to 24,584 short tons worth \$106,419. The value of the feldspar varies with the quality and its state of preparation. Selected crude spar has sold recently for \$4.50 and \$5 a ton. The ground spar for enamel and similar purposes is worth from \$7 to \$8 and for pottery \$8 to \$10 a ton. Unsorted crushed pegmatite brings about \$3 a ton at the mill.

The quarries now in operation are situated in Essex and Westchester counties. The Crown Point Spar Co. and the Barrett Manufacturing Co. work quarries in the former county at Crown Point and Ticonderoga respectively. Their main products are unsorted pegmatite. In Westchester county, near the village of Bedford are the quarries of P. H. Kinkel & Sons and the Bedford Spar Co. which produce spar for grinding.

GARNET

The output of abrasive garnet in the past year was obtained from the usual sources—the deposits in the vicinity of North Creek, Warren county. For many years these deposits have contributed the larger part of the supply that has been mined in the country, which means practically the supply for the whole world, since the output in foreign countries is limited to a few hundred tons annually and is mainly from a single district in Spain. The

employment of garnet as an abrasive is peculiarly an American development, and although firmly established in certain manufacturing lines here, as shown by the steady demand in spite of the very active competition of other abrasives natural and artificial, apparently it has made little progress in foreign countries.

The Adirondack deposits have been repeatedly described in the reports of the New York State Museum and elsewhere so that there is no need to discuss their features at length in this place. Briefly, they consist of various gneisses and massive rocks which carry disseminated crystals and aggregates of garnet of the variety known as almandite. In some places, as instanced by the Rogers mine on Gore mountain, the garnet is found in crystals that range up to several feet across and weigh a ton or more, but elsewhere the mineral is mostly in individuals that measure an inch or less in diameter. The larger individuals seldom show any outward crystal development but have rounded or lenticular outlines and are traversed by innumerable fractures or parting planes. When the crystals are broken into, the particles of garnet are picked out by hand with the aid of cobbing tools, such garnet being known as shell and pocket garnet. This method of hand work, with the aid of blasting to break up the rock, is practised on Gore mountain where the conditions are exceptionally favorable for its use on account of the relative richness of the rock and the large size of the crystals. In the other deposits the rock is quarried with no attempt at sorting and is then crushed in mills to a size which releases the garnet from the matrix. The mineral is removed from the crushed product by treatment in jigs or by pneumatic separators. The mechanical separation yields a clean concentrate, although there is a small margin between the specific gravity of almandite and that of the hornblende which is an important constituent of the rock.

The utility of garnet for abrasive purposes depends upon its hardness, toughness and cleavage or fracture. Almandite, which is the variety employed, is usually assigned a hardness of 7 to 7.5 by mineralogists; that is, it exceeds quartz in that respect but is not quite so hard as topaz. It appears that Adirondack almandite of the crystal variety possesses superior hardness, and is rated as 7.5 or 8. Toughness and strength are important qualities, especially when the abrasive is used under considerable pressure. A material may be very hard and yet brittle or crumbly under pressure. The well-crystallized almandite, free from impurities, has great strength and gives good service on polishing machines. The presence of

mica and chlorite is an element of weakness, inasmuch as they provide surfaces along which the garnet fractures more or less readily. An imperfect cleavage or parting that results from regional compression, however, is not detrimental and may be an advantage if not too pronounced. The color of garnet can not be used as a criterion of quality, but abrasive manufacturers usually express a preference for the dark shades which show a good red color when applied to paper or cloth. It is important, also, that the garnet crystals be sufficiently large so that when crushed and separated from the rock matrix the garnet will not be too fine but will afford the desirable assortment of sizes. The normal result of milling a small crystal is to produce an excess of the finer sizes. Much of the garnetiferous rock that occurs in various parts of the Adirondacks and elsewhere can not be utilized because of the small crystal, if for no other reason.

Besides the Adirondacks, North Carolina and New Hampshire have supplied some abrasive garnet in recent years, and mines now inactive are found in several other states within the Appalachian metamorphic belt.

The wood-working and leather manufacturing industries are the principal consumers of garnet which is used in the form of garnet paper and garnet cloth. "Ruby" paper is a common name for the manufactured material. Its efficiency is said to be several times greater than ordinary quartz sandpaper.

The garnet mines in the Adirondacks were first developed for commercial production about 1882. The earliest operations were on Gore mountain, in connection with the remarkable deposit known as the Rogers mine. This is by far the richest of the mines and as already stated is worked by hand. The output for the first few years probably did not amount to more than a few hundred tons annually. By 1893, however, it had grown to 1475 tons, according to figures published in *The Mineral Industry*. The next important development came with the introduction of mechanical methods for the separation of the garnet, due to the initiative of the Messrs Hooper who constructed the first mill on a property lying a little west of North River in the town of Minerva, Essex county. The garnet here occurred in smaller crystals than in the Rogers mine and could not be economically handled by the methods adopted at that mine. The North River Garnet Co. later built a mill which it now operates on Thirteenth lake, Warren county, the first mill having been dismantled. The production of garnet from 1904 to date has been as follows:

Production of Garnet

YEAR	SHORT TONS	VALUE
1904.....	3 045	\$104 325
1905.....	2 700	94 500
1906.....	4 729	159 298
1907.....	5 709	174 800
1908.....	2 480	79 890
1909.....	3 802	119 190
1910.....	5 297	151 700
1911.....	4 285	121 759
1912.....	4 112	117 325
1913.....	4 665	145 445
1914.....	4 026	134 940

The statistics show that the production has continued fairly steady from year to year, but does not manifest any marked growth. The value of the product has remained at about the same level also, the prices ranging around \$30 and \$35 a ton, depending on the quality. The mill product when it is clean crystal garnet of good color commands the highest prices.

The garnet is practically all sold in this country. The domestic manufacturers also import some garnet from Spain where it is obtained by the washing of river sands. This garnet is of fine size and hence finds a rather limited application. It is said to cost about \$15 a ton laid down at the Spanish seaboard, which is much less than the cost of mining the Adirondack mineral.

The imports for the year 1914, as given by the collectors of customs at the ports of New York and Boston, were 1244 short tons with a declared value of \$20,277. In 1913 they amounted to 547 short tons with a value of \$8078.

GRAPHITE

The usual output of crystalline graphite was made last year in the Adirondack region, and as heretofore the main source of supply was the American mine at Graphite, Warren county, which has had a long record as a producer. The mine affords a very light, flaky graphite that commands a special market. The graphite occurs in disseminated condition through the body of a hard quartzite, requiring special methods for its extraction and preparation, which have been perfected by the owners of the mine, the Joseph Dixon Crucible Co. The rock is crushed and the graphite extracted in a mill situated at the mine, and the crude product is then refined and finished at a second plant in Ticonderoga.

The occurrence of graphitic quartzites has been shown by prospecting to be quite common in the eastern section of the Adirondacks, in Warren, Washington and Essex counties, and considerable deposits occur also in the northwestern part in St Lawrence county. The separate areas represent, apparently, the broken, eroded remnants of once extensive beds which belong to a single formation. They are interbedded with crystalline limestones, schists and garnetiferous gneisses that belong to the Grenville series of the early Precambrian. The stratigraphic position of the quartzites in the bedded series has not been determined, owing to their greatly disturbed and eroded condition. The quartzites and quartz schists are hardened sandstones, and the graphite almost certainly is of organic origin, derived from plant or animal remains included in the rocks at the time of their deposition. The graphite content is quite constant within the same layers of a deposit, though it may vary considerably in a direction at right angles to the bedding planes. There is great variation in the graphite percentages in the different occurrences, the richest deposits carrying around 8 or 10 per cent, whereas the usual average is not over 2 or 3 per cent. Rock with less than 5 per cent can not be considered as within the range of economic utilization. There are other factors that have to be considered in addition to the graphite tenor, such as the size of flake, the presence of other scaly minerals, and the degree of crushing that is necessary to effect a separation of the graphite from the gangue. Very rarely does a deposit possess all the requisites for economic production; in fact the American mine is the only one of a number of enterprises to win a permanent success in the industry.

One of the commoner difficulties in the way of utilizing the Adirondack deposits pertains to the presence of more or less mica which is disseminated usually through the quartzite in intimate association with the graphite. The particles are of approximately similar size, and being of the black variety (biotite) they may be readily overlooked in the hand specimen or in the graphite concentrate. The easiest method of detecting the mica and of estimating its relative proportion to the graphite is to examine the material under the microscope when the former can be readily distinguished by its translucency. The results of previous experience in mill treatment with the use of buddles, concentrating tables, pneumatic jigs and screens have shown that the mica can not be eliminated by such methods. There is a possibility that this difficulty may be overcome through the use of an electrostatic process, such as has been perfected in recent years and applied with some success to the metallic

ores. The process, it may be explained in a word, makes use of the differences of electric conductivity in the separation of minerals; inasmuch as graphite is a good conductor and mica a very poor one there seems to be a basis at least for experimentation in this field.

GYPSUM

The gypsum mines of the State were not quite so actively worked last year as in the preceding season, but still yielded a large output. The decrease in tonnage which was of small proportions may be attributed to the poor market for calcined products which in turn was influenced by the decline of building operations throughout the East. The market for gypsum plasters for a time was oversupplied and became almost demoralized by the competition among mills for the little trade that existed. In some building centers these products were offered at prices which left little or no profit to the manufacturer. In view of the enormous development of the industry that has taken place in the last few years it is but natural that the production finally should reach a point where it equaled or exceeded the requirements, a condition that obtained last year for the first time. With the resumption of normal activity in the market the industry doubtless will rapidly recover from the depression.

The production of gypsum last year was reported from four counties — Onondaga, Monroe, Genesee and Erie. There are several others that contain deposits, since the district extends all the way from Madison county on the east to the Niagara river, but the present mine localities have certain advantages as to quality of the rock or for economic extraction and marketing of the materials. The thickest deposits are found in the east in Onondaga, Cayuga and Madison counties where they attain a maximum of from 15 to 40 feet. The grade is somewhat inferior, however, the gypsum being intermixed with clayey and calcareous impurities and having a rather dark color. These deposits consequently are not employed generally for calcined plasters, but are useful as sources of agricultural plaster. In Monroe, Genesee and Erie counties, the deposits are much thinner, averaging 4 or 5 feet in most places, but have a higher purity so that the rock is well adapted for practically all purposes. Most of the output in these counties is calcined, but a fairly large proportion is sold crude to cement manufacturers.

The total output was 513,094 short tons or about 20,000 tons less than in 1913. The following table shows the output distributed according to uses for the two years.

Production of gypsum

MATERIAL	1913		1914	
	Short tons	Value	Short tons	Value
Total output, crude.....	532 884	.....	513 094	.....
Sold crude.....	183 597	\$265 879	169 257	\$246 804
Ground for land plaster....	8 521	17 807	7 096	15 342
Wall plaster, etc. made.....	306 206	1 022 457	297 084	985 258
Total.....	.....	\$1 306 143	.....	\$1 247 404

There were few new developments in progress during the year. Prospecting was practically at a standstill, but will doubtless be resumed once the conditions begin to improve. The developed ground in the western section is confined to a few areas which are controlled by the present mining companies, and the future growth of the industry will depend upon the discovery of additional deposits. The number of active mines was eight, one less than in 1913. In the Akron district, the Akron Gypsum Products Corporation became a producer, having taken over the mines and mill formerly owned by the Akron Gypsum Co.

IRON ORE

The iron trade was greatly depressed throughout 1914, and the output of ore consequently showed a marked decline as compared with the production for the few preceding years. The curtailment of demand was accompanied by a lowering of prices which worked to the special disadvantage of the local industry owing to the fact that most of the output is now made from low-grade milling ores that involve treatment in elaborate plants with heavy costs of operation.

Besides the decreased demand and falling prices another factor that discouraged activity was the putting into effect of the new compensation act, the terms of which as applied to the mining industry were regarded by the operators as rather drastic. One of the companies that had been active for a number of years preferred to withdraw from business rather than comply with the conditions imposed by the law. Some time must elapse before the effects of the new regulations can be fully determined.

The production of furnace ores and concentrates as reported by the different mines that were operative within the State was 751,716 long tons. In comparison with the total reported for the preceding year, this represented a decrease of 466,183 tons, or nearly 40 per cent. It was the smallest output recorded in the last ten years with the exception of that for 1908. The value of the product at the mine was \$2,356,517, or an average of \$3.13 a ton.

Of the total, the magnetite represented 703,670 tons, with a value of \$2,251,656. Hematite constituted the remainder with the exception of a few hundred tons of limonite from Columbia county. The hematite all came from the Clinton belt in Oneida and Wayne counties; the magnetite was mainly from the Adirondacks, with a smaller but important part from the mines in Orange county.

Production of iron ore in New York State

YEAR	MAGNE- TITE	HEMA- TITE	LIMO- NITE	CARBO- NATE	TOTAL	TOTAL VALUE	VALUE A TON
	Long tons	Long tons	Long tons	Long tons	Long tons		
1895	260 139	6 769	26 462	13 886	307 256	\$598 313	\$1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
1903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
1906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75
1907	853 579	164 434	Nil	Nil	1 018 013	3 750 493	3 68
1908	663 648	33 825	Nil	Nil	697 473	2 098 247	3 01
1909	934 274	56 734	Nil	Nil	991 008	3 179 358	3 21
1910	1 075 026	79 206	4 835	Nil	1 159 067	3 906 478	3 37
1911	909 359	38 005	5 000	Nil	952 364	3 184 057	3 34
1912	954 320	103 382	Nil	Nil	1 057 702	3 349 095	3 17
1913	1 097 208	120 691	Nil	Nil	1 217 899	3 870 841	3 18
1914	703 670	47 705	341	Nil	751 716	2 356 517	3 13

The magnetite consisted largely of concentrates, some of the Adirondack mines shipping all their product in that form. A ton of concentrates, which on the average contains 65 per cent iron, represents from a little over 1 to 3 tons of crude ore, according to the grade of the particular ore body. The actual amount of magnetite

raised from the mines during the year was 1,074,175 tons; and the total quantity of ore of all kinds taken out was 1,122,221 tons. In 1914 the gross output amounted to 1,606,196 tons.

The list of the active mining companies for the year included the following in the Adirondack region: Witherbee, Sherman & Co., and Port Henry Iron Ore Co., Mineville; Cheever Iron Ore Co., Port Henry; Chateaugay Ore & Iron Co., Lyon Mountain; Benson Mines Co., Benson Mines. In southeastern New York the producers were the Hudson Iron Co., Fort Montgomery, and Sterling Iron & Railway Co., Lakeville. The hematite mines were operated by C. H. Borst, Clinton; Furnaceville Iron Co., Ontario Center; and Ontario Iron Co., Ontario Center. The single limonite mine was operated by Barnum Richardson & Co., who shipped the output to their furnaces in Connecticut.

Mineville. The two Mineville companies supplied a little over one-half of the total product of furnace ore, but their output was considerably below that reported for 1913. Operations in the latter part of the year were hampered by the loss of milling capacity due to the burning of the two older mills, No. 1 and No. 2, on the Joker-Bonanza properties of Witherbee, Sherman & Co. This left only No. 3 and No. 4 mills on the Harmony and Barton Hill mines to handle the output. Construction work was immediately started upon a new magnetic concentration plant which will have a capacity equal to that of the mills that were destroyed, and which will treat the high-phosphorus ores of the Old Bed mine group.

The mines under active operation during the year included the Joker-Bonanza, Harmony and Barton Hill groups of Witherbee, Sherman & Co., and 21 and Clonan shafts of the Port Henry Iron Ore Co. In the Joker-Bonanza territory attention was directed mainly to the flat seam which underlies the main ore body and resulted in the further extension of the productive ground.

Lake Sanford. The most important recent development in connection with the titaniferous magnetites of this locality has been the experimentation in smelting the ores on a practical scale, for which purpose the MacIntyre Iron Co. secured a lease of the Port Henry blast furnace for a part of the past year and conducted a series of tests in the production of pig iron with varying portions of Lake Sanford magnetite in the charge. The interest and value of the tests are more than local, as they seem to have demonstrated the commercial utility of the great bodies of ore which the company owns in the Adirondacks and which doubtless it will undertake to bring into market.

The furnace tests are the subject of a very complete report¹ by F. E. Bachman, who as metallurgical expert and manager of the company was present during the trial. It appears that the magnetites involved no special difficulties in treatment, at least when employed to the extent of one-third or one-fourth of the charge, and therefore their use will not require any important modifications of present methods or equipment. For the metallurgical details, on which the conclusions here given are based, the report should be consulted.

The tests were made with concentrates prepared in a small experimental mill at the mines and also at the commercial mills (Nos. 1, 2 and 4) at Mineville. In none of the plants was the treatment of the crude ore very successful, since the iron content was not raised above 55 or 56 per cent, while the titanic acid averaged around 12 or 13 per cent. The quality of the concentrates may be considerably improved, when once the mill practice has been modified to meet the physical conditions of the ores which are not the same as those characterizing the nontitaniferous class. Previous experiments on a fairly large scale indicate that the iron may be brought up to about 60 per cent with a titanium content of 10 per cent or less.

In so far as the furnace tests are concerned, the results indicate that the Lake Sanford magnetites are no more refractory than the ordinary magnetites. The fuel consumption in the reduction of the iron actually may be lower, although counterbalanced by the somewhat greater proportion of slag produced to the unit of iron. The titaniferous slags are more fluid than those free of titanium, contrary to what has been commonly supposed, and there is less tendency for the furnace to hang and slip when operated on a titaniferous charge. The quality of the iron is good, numerous tests indicating that it is stronger than ordinary pig of the same silicon content. It contains less sulphur and the silicon is lower by an amount corresponding to one-half of the titanium content. The latter ordinarily does not exceed about one-half of 1 per cent. The iron contains up to one-tenth of 1 per cent of vanadium.

MILLSTONES

Millstones are quarried from the Shawangunk grit of Ulster county, one of the few sources of these materials in the United States. The industry was established there many years ago, and

¹ Amer. Iron and Steel Inst., Oct. 1914.

during the earlier period of its history was in a flourishing state as the product found a wide sale for the grinding of cereals. This market has been greatly curtailed within the last quarter of a century or more by the general use of the roller mill process for making flour, although some mills still make use of stones for grinding the coarse grains. The small corn mills in the South furnish one of the larger markets for the New York product. Besides millstones, the Ulster county quarries also turn out disks of stone known as chasers which are employed in a roll type of crusher, the disks revolving on a horizontal axis in a circular pan that is sometimes floored by blocks of the same stone. This type of crusher is much used in the grinding of minerals like quartz, barytes and feldspar, and paint materials.

The Shawangunk grit of which the stones are made outcrops on Shawangunk mountain, a monoclinical ridge that extends from Rosendale southwesterly into New Jersey and Pennsylvania. The grit forms the top of the ridge, dipping to the west in conformity with the slope of the surface, and in the Walkill valley along the north side disappears below shales and limestones which belong to the uppermost formations of the Siluric. The grit rests unconformably upon the Hudson River series. In thickness it ranges from 50 to 200 feet. The millstones are quarried within a limited section of the ridge, between High Falls on the north and Kerhonkson on the south, where the grit appears to be best adapted to the purpose. In character it is a light gray conglomerate with pebbles of milky quartz ranging in size from that of a pea to 2 inches in diameter. The pebbles are rounded and firmly cemented by a silicious matrix of gritty texture.

The work of quarrying requires only a small equipment, the stone being pried out by hand bars, after the use perhaps of the drill and plugs and feathers. Sometimes a little powder may be employed, but care has to be exercised in its use to avoid weakening the stone. The spacing of the natural joints determines the size of the stone that may be produced, the joints occurring in two sets approximately parallel to the dip and strike of the formation. The rough blocks thus obtained are reduced to shape by the hammer and point and then undergo a final tool dressing which varies with the use to which the stone is to be put. The hole or "eye" in the center is drilled by hand.

The sizes of the stone marketed ranges from 15 to 90 inches in diameter. The greater demand is for the smaller and medium sizes with diameters of 24, 30, 36, 42 and 48 inches. The chasers

are supplied in sizes that usually run from 48 to 90 inches and with widths up to 24 inches. The prices range from \$3 for an 18 inch stone to \$75 or \$100 for the largest sizes.

The production at one time was valued at over \$100,000 a year, but within the last decade it has averaged less than \$20,000. During 1914 the total sales of millstones and chasers were reported as \$12,410 as compared with \$13,130, the value of the stones marketed in 1913.

MINERAL PAINT

For the purposes of the present report only the natural mineral pigments are included under this title. In addition to these materials, there is a production in the State of artificial pigments, especially those of lead, but as the substance used in their manufacture is derived from outside sources, they have not been included among the local products.

The crude paint materials that occur within the State include iron ore, ocher, shale and slate. Of the iron ores the Clinton hematite affords an excellent base for the manufacture of metallic paint and mortar color of red to brownish red colors. The beds with a relatively high iron content are employed, as they possess the softness and uniformity of texture, as well as depth of color which are requisite for such use. The ore is obtained from the mines at Clinton, Oneida county, owned by C. A. Borst and from those at Ontario, Wayne county, worked by the Furnaceville Iron Co. The hematite from the former locality is of oölitic nature and carries about 45 per cent iron. The ore from Ontario contains about 40 per cent iron and is known as "fossil" ore. In years past the red hematite from the northern part of the State has also been employed, but recently this ore has not been obtainable.

Both shale and slate from the local formations have been used quite extensively for pigments. They occur in various colors depending upon the amount and nature of the iron oxides present. A large percentage of ferric oxide lends a reddish color which resembles that of metallic paint. Red shale has been obtained from the base of the Salina beds near Herkimer. The red slate from Washington county is another material that has been quite extensively ground for pigment. At Randolph, Cattaraugus county, beds of green, brown and bluish shale occur in the Chemung formations and have been utilized in the past.

Deposits of ferruginous clay, or ocher, are found in many places within the State, but they are not now worked. Sienna, a dark

brown variety of ocher, is found near Whitehall where it was produced a few years ago.

The production of mineral paint and mortar colors in 1914 amounted to 7321 short tons, valued at \$88,720. That of slate pigment was 1182 short tons worth \$9620. In addition to these outputs of manufactured pigments, there was a considerable quantity of material produced that was shipped to points outside for grinding into pigments.

MINERAL WATERS

New York has held for a long time a leading position among the states in the utilization of mineral waters. The different springs, of which over two hundred have been listed as productive at one time or another, yield a great variety of waters in respect to the character and amount of their dissolved solids. There are some that contain relatively large amounts of mineral ingredients and are specially valuable for medicinal purposes; Saratoga Springs, Ballston Springs, Richfield Springs, Sharon Springs and Lebanon Springs are among the more noted localities for such waters. Numerous other springs are more particularly adapted for table use, containing only sufficient mineral matter to give them a pleasant saline taste. Both kinds of waters are generally carbonated and sold in small bottles.

Of late there has developed an important business in the sale of spring waters which can hardly be classed as mineral in the common acceptance of the word, but which are extensively consumed for office and family use in the larger towns and cities. Their employment depends upon their freedom from harmful impurities, in which feature they are generally superior to the local supplies. In so far as such waters are an article of commerce they may well be included in a canvass of the mineral water industry. They are usually distributed in large bottles or carboys in noncarbonated condition.

Character of mineral waters. Among the spring waters that contain mineral ingredients in appreciable quantity, those characterized by the presence of alkalis and alkaline earths are the most abundant in the State. The dissolved bases may exist in association with chlorin and carbon dioxid, as in the springs of Saratoga county, or they may be associated chiefly with sulphuric acid, as illustrated by the Sharon and Clifton Springs.

The mineral waters of Saratoga Springs and Ballston are found along fractured zones in Lower Siluric strata, the reservoirs occurring usually in the Trenton limestone. They are accompanied by

free carbon dioxid which, together with chlorin, sodium, potassium, calcium and magnesium, also exists in dissolved condition. The amount of solid constituents in the different waters varies from less than 100 to over 500 grains a bottle. Large quantities of table and medicinal waters are bottled at the springs for shipment to all parts of the country. The carbon dioxid which issues from the wells at Saratoga at one time was an important article of commerce, but its sale has been discontinued.

The waters at Richfield Springs contain the elements of the alkali and alkaline earth groups together with sulphuric acid and smaller amounts of chlorin, carbon dioxid and sulphureted hydrogen. They are employed for medicinal baths as well as for drinking purposes. The springs issue along the contact of Siluric limestone and Devonian shales. Sharon Springs is situated to the east of Richfield Springs and near the contact of the Lower and Upper Siluric. Clifton Springs, Ontario county, and Massena Springs, St. Lawrence county, are among the localities where sulphureted waters occur and are utilized.

The Oak Orchard springs in the town of Byron, Genesee county, are noteworthy for their acid waters which contain a considerable proportion of aluminum, iron, calcium and magnesium, besides free sulphuric acid.

The Lebanon spring, Columbia county, is the single representative in the State of the class of thermal springs. It has a temperature of 75° F. and is slightly charged with carbon dioxid and nitrogen.

Ordinary spring waters. The greater quantity of spring waters consumed in the State belongs to the nonmedicinal, noncarbonated class, represented by such springs as the Great Bear, Deep Rock, Mount View, Sun Ray, Chemung etc. The waters are obtained either by flowing springs or from artesian wells and are shipped in carboys or in tank cars to the principal cities where they are bottled and distributed by wagons among the consumers. The essential feature of such waters is their freedom from noxious impurities. This is generally safeguarded by the care exercised in the handling of the waters which are also regularly examined in the chemical and bacteriological laboratories.

Carbon dioxid. Carbon dioxid is given off in quantity by some of the wells at Saratoga Springs, and its collection and storage for shipment constituted for many years an important industry at that place. Over thirty wells have been bored there for gas alone. The industry has now been discontinued by force of a legislative enact-

ment; it was considered that the pumping of the wells for the production of the gas was detrimental to the other springs that were utilized solely for their waters. For some time the value of the natural gas secured from the wells exceeded that of the mineral water sales.

List of springs. The following list includes the names and localities of most of the springs in the State that are employed commercially, as shown by a canvass of the industry:

NAME	LOCALITY
Baldwin Mineral Spring.....	Cayuga, Cayuga county
Coyle & Caywood (Arrowhead Spring)...	Weedsport, Cayuga county
Diamond Rock Spring.....	Cherry Creek, Chautauqua county
Breesport Oxygenated Spring.....	Breesport, Chemung county
Breesport Deep Rock Water Co.....	Breesport, Chemung county
Chemung Spring Water Co.....	Chemung, Chemung county
Keeseville Mineral Spring.....	Keeseville, Clinton county
Lebanon Mineral Spring.....	Lebanon, Columbia county
Arlington Spring.....	Arlington, Dutchess county
Mount Beacon Spring.....	Mount Beacon, Dutchess county
Mount View Spring.....	Poughkeepsie, Dutchess county
Monarch Spring Water Co.....	Beacon, Dutchess county
Elk Spring Water Co.....	Lancaster, Erie county
Clinton Lithia Springs, Inc.....	Franklin Springs, Oneida county
Glen Alix Spring.....	Washington Mills, Oneida county
Lithia Polaris Spring.....	Boonville, Oneida county
F. H. Suppe (Franklin Lithia Spring)...	Franklin Springs, Oneida county
Orville Risley.....	New York Mills, Oneida county
Geneva Mineral Water Springs.....	Geneva, Ontario county
Crystal Spring.....	Oswego, Oswego county
Deep Rock Spring.....	Oswego, Oswego county
Great Bear Spring.....	Fulton, Oswego county
White Sulphur Spring.....	Richfield Springs, Otsego county
Black Rock Spring.....	Rensselaer, Rensselaer county
Mammoth Spring.....	North Greenbush, Rensselaer county
Shell Rock Spring.....	East Greenbush, Rensselaer county
Madrid Indian Spring.....	Madrid, St Lawrence county
Artesian Lithia Spring.....	Ballston Spa, Saratoga county
Comstock Mineral Spring.....	Ballston Spa, Saratoga county
Mohican Spring.....	Ballston Spa, Saratoga county
Arondack Spring.....	Saratoga Springs, Saratoga county
Hathorn (Nos. 1 and 2) Springs.....	Saratoga Springs, Saratoga county
Coesa Spring.....	Saratoga Springs, Saratoga county
Geyser Spring.....	Saratoga Springs, Saratoga county
Minnonebe Spring.....	Saratoga Springs, Saratoga county
Orenda Spring.....	Saratoga Springs, Saratoga county
Saratoga Gurn Spring.....	Saratoga Springs, Saratoga county
Saratoga Vichy Spring.....	Saratoga Springs, Saratoga county
Chalybeate Spring.....	Sharon Springs, Schoharie county
Eye Water Spring.....	Sharon Springs, Schoharie county
Sulphur-Magnesia Spring.....	Sharon Springs, Schoharie county
White Sulphur Spring.....	Sharon Springs, Schoharie county
Red Jacket Spring.....	Seneca Falls, Seneca county
Setauket Spring.....	Setauket, Suffolk county
Elixir Spring.....	Clintondale, Ulster county
Sun Ray Spring.....	Ellenville, Ulster county
Vita Spring.....	Fort Edward, Washington county
Briarcliff Lodge Association.....	Briarcliff Manor, Westchester county
Gramatan Spring Water Co.....	Bronxville, Westchester county
Orchard Spring.....	Yorkt'n Heights, Westchester county

NATURAL GAS

The natural gas industry had a slight setback last year, the production having fallen off in some of the more important districts. The decrease was the result of natural causes, not involved in any way with the general business depression, as shown by the fact that the value of the output actually was larger than in the preceding year. There were no discoveries of new pools to counterbalance the normal decline of flow in the older territory.

The flow of gas as reported by the individual producers and pipeline companies amounted to 8,714,681,000 cubic feet, as compared with 9,055,429,000 cubic feet in 1913, a decline of nearly 4 per cent. On the other hand, the value of the output, according to reports, reached \$2,570,165 against \$2,549,227, and was the largest that has ever been recorded. The value is based on the average prices received for the gas in the different centers of consumption. The average price for the whole State was 29.4 cents a thousand, as compared with 27.8 cents in 1913.

The production of gas in the State since 1904 when the statistics were first collected by this office, is shown in the accompanying table. In former years it has been feasible to separate the production according to the county or district in which it was made, but owing to the recent changes in the industry, particularly in the organization of large distributing companies who derive their supplies from different fields, the statistics can no longer be separated by counties.

Production of natural gas

YEAR	OUTPUT 1000 CU. FT.	VALUE	NUMBER OF WELLS
1904.....	2 399 987	\$552 197	.....
1905.....	2 639 130	607 000	.....
1906.....	3 007 086	766 579	.....
1907.....	3 052 145	800 014	925
1908.....	3 860 000	987 775	1 100
1909.....	3 825 215	1 045 693	1 280
1910.....	4 815 643	1 411 699	1 340
1911.....	5 127 571	1 547 077	1 403
1912.....	6 564 659	1 882 297	1 660
1913.....	9 055 429	2 549 227	1 750
1914.....	8 714 681	2 570 165	1 797

The returns for 1914 showed about 200 individual producers with a total of 1797 wells. More than one-half of the producers were in

Chautauqua county, but most of the number had only one well which was used for the supply of a single household. The production of this county was 1,270,546,000 cubic feet with a value of \$350,904. Erie had the largest output of any county, although its actual production can not be definitely stated. The four counties of Allegany, Cattaraugus, Erie and Genesee together contributed a total of 7,139,920,000 cubic feet valued at \$2,095,945, which was a little less than in 1913. The production represented the flow of 1456 wells and did not include the gas consumed in the oil district for pumping operations. Of other counties which contributed, Ontario was the most important with a total of 157,124,000 cubic feet valued at \$52,574. Altogether there were fifteen counties represented in the industry.

The business of distributing the output among the cities and communities within the different districts is controlled by a relatively few companies, some of whom are employed also in productive operations. The largest single distributor is the Iroquois Natural Gas Co. of Buffalo with pipe lines to the principal fields in Allegany, Cattaraugus, Erie and Genesee counties. The Alden-Batavia Natural Gas Co. and the Pavilion Natural Gas Co. are important producers and distributors in the Erie-Genesee county district. In Chautauqua county the larger operators include the Frost Gas Co., the Silver Creek Gas & Improvement Co., and the South Shore Natural Gas & Fuel Co. In Allegany and Cattaraugus counties the Gowanda Natural Gas Co., the Empire Gas & Fuel Co. and the Producers Gas Co. have pipe lines. In Ontario county the main producer and distributor is the Ontario Gas Co. Among the smaller companies engaged in the business are the Consumers Natural Gas Co. with wells in the town of Darien, Schuyler county, the Baldwinsville Light & Heat Co. of Baldwinsville, Onondaga county, the Pulaski Gas & Oil Co. of Pulaski, Oswego county, and the Sandy Creek Oil & Gas Co. of Sandy Creek, Oswego county.

The geological occurrence of natural gas in the State has been described in various reports issued by the New York State Museum. The productive gas pools are distributed over portions of sixteen counties, but they are all in the section that lies west of the 76th meridian, which crosses the west end of Oneida lake. Discoveries have been reported from time to time in the eastern part of the State, notably in the sections along the Mohawk river as far east as Albany county; in this region, however, the gas seems to be confined to small pockets which are rapidly depleted.

The most prolific gas pools thus far found are in the sandstones

of the Medina formation, near the top of the latter. This formation outcrops in a belt along the south shore of Lake Ontario and consists mainly of shale with sandstones in the upper part, with an aggregate thickness of about 1200 feet. It extends along the lake shore from the Niagara river to Oswego county, and continues eastward for some distance beyond the limits of this county. The strata have been little disturbed or changed since their uplift. They dip slightly toward the south or southeast, the average inclination being about 50 feet to the mile. The dip together with the rising elevation toward the south soon brings the strata under a considerable cover which increases progressively with the distance from the outcrop. The important gas pools of Erie and Genesee counties occur in the Medina at depths of from 1200 to 1800 feet; those in the southern part of Erie county being the deepest. The lake shore gas belt of Chautauqua county also derives its main supply from the Medina which is encountered at depths of 1900-2300 feet. The deepest explorations have been in northern Cattaraugus county, where gas sands supposedly belonging to the Medina have been encountered at 2500-3300 feet.

Next to the Medina, the most important horizon is in the Chemung sandstones at the top of the Devonian, the same strata that yield the petroleum production of New York. The wells are from 600 to 1800 feet deep and were primarily drilled for oil, but the gas is an important subsidiary product that is utilized in part for pumping the wells. The excess is piped to the communities in the district and as far as Buffalo.

The Trenton limestone affords a small supply of gas which is developed at Pulaski and Sandy Creek, Oswego county, at the east end of Lake Ontario and at Baldwinsville, Onondaga county. At the localities first named the wells are 1200-1500 feet deep and at Baldwinsville 2400 feet.

PETROLEUM

The oil industry, which is confined to a small area in the southwestern part of the State, has not been attended by any notable discoveries or new developments during the past year. The production, however, was of the usual proportions, as in fact it has changed very little within the last quarter of a century. The maintenance of the yield may be said to be the most remarkable feature of the local industry, contrasting in that respect with many fields which have had a much larger initial production. It is largely the result of a policy of conservation and economy that has been pursued by

the producers. There is still undrilled territory within the limits of the productive pools, and the gradual development of this ground with the cleaning and redrilling of old wells suffice to keep the production at a nearly constant level. The economy with which the operations are conducted is indicated by the fact that the average yield is now only one-third of a barrel a day.

The run of oil in 1914 as reported by the pipe-line companies and other shippers amounted to 933,511 barrels. This showed a small increase over the total for 1913 which was 916,873 barrels, and there would have been a still larger gain, doubtless, if the prices had remained at the level which prevailed in the early months. A decline of over \$1 a barrel took place during the summer and served to discourage new drilling. The outlook for development work in the current season is not very promising.

The record of field work, as compiled monthly by the Oil City Derrick, showed that 267 wells were drilled last year in New York territory. This was only about one-half the number drilled in 1913 when prices for crude oil rose rapidly in the first months, the actual number drilled in that year having been 512. In 1912 the reports showed 246 new wells. The increment of production from the new wells amounted to 446 barrels, as compared with 810 barrels in 1913 and 278 barrels in 1912. Of the number of wells completed, 17 were dry as compared with 48 in 1913 and 66 in 1912.

The market prices of New York crude oil are based on the quotations of Pennsylvania crude which are the highest in the market. During the first four months of 1914 the quotations remained unchanged at \$2.50 a barrel, which level they had reached early in 1913. On this basis there was a very good profit in production and the industry was very active. In May, however, the prices declined abruptly to \$1.90, and thereafter fell off gradually month by month until in September they reached \$1.45 at which they remained to the close of the year. The causes of the rapid rise and decline seem to be unexplainable from the standpoint of the market situation, as there were no such variations in the prices of the refined products.

Production of petroleum in New York

YEAR	BARRELS	VALUE
1895.....	912 948	\$1 240 468
1896.....	1 205 220	1 420 653
1897.....	1 279 155	1 005 736
1898.....	1 205 250	1 098 284
1899.....	1 320 909	1 708 926
1900.....	1 300 925	1 759 501
1901.....	1 206 618	1 460 000
1902.....	1 119 730	1 530 852
1903.....	1 162 978	1 849 135
1904.....	1 036 179	1 709 770
1905.....	949 511	1 566 931
1906.....	1 043 088	1 721 095
1907.....	1 052 324	1 736 335
1908.....	1 160 128	2 071 533
1909.....	1 160 402	1 914 663
1910.....	1 073 650	1 458 194
1911.....	955 314	1 251 461
1912.....	782 661	1 338 350
1913.....	916 873	2 255 508
1914.....	933 511	1 773 671

The statistics of production for the last two decades are shown in the accompanying table. The figures for the period 1895-1903 have been taken from the annual volumes of the Mineral Resources and those for the following years compiled from the individual reports rendered by the pipe-line companies and shippers who operate in the State. The list of these companies follows: Columbia Pipe Line Co., Union Pipe Line Co., Fords Brook Pipe Line Co., Buena Vista Oil Co. and Madison Pipe Line Co., of Wellsville; Vacuum Oil Co., Rochester; New York Transit Co., Olean; Emery Pipe Line Co., Allegany Pipe Line Co., Tide Water Pipe Co., Limited, and Kendall Refining Co., of Bradford, Pa.

The oil is found in fine-grained sandstones of dark color belonging to the Chemung formation, at the top of the Devonian system. In Cattaraugus county the productive area embraces about 40 square miles, mostly in Olean, Allegany and Carrollton townships. The pools, of which the principal ones are the Ricebrook, Chipmunk, Allegany and Flatstone, occur at several horizons from 600 to 1800 feet below the surface. The oil district of Allegany county extends across the southern townships of Clarksville, Seneca, Wirt, Bolivar, Alma, Scio and Andover and is divided into several pools that are considered to be more or less independent. The Bolivar, Richburg and Wirt pools have been most productive. The oil is found at depths of from 1400 to 1800 feet. The Andover pool

lies partly in the town of West Union, Steuben county, and is accountable for the production in that section.

The productive wells in the three counties number about 10,500, of which 7500 are in Allegany county, 200 in Steuben and the remainder in Cattaraugus county. All are pumped, using natural gas derived from some of them for power. The average yield is now less than one-third of a barrel a day.

SALT

The salt industry shared in the general decline which characterized most of the business activities last year and reported a considerable falling off in output. The decline was the first serious interruption to progress that the industry has felt in some time, in fact since the panic times of 1907 when there was a temporary but rather serious drop in production. As a whole, however, the conditions were not particularly hard upon the producers, as they would have been if accompanied by a corresponding shrinkage of prices; but the latter seem to have been well maintained according to the averages reported for the values of the different grades.

The statistics for the last two years are summarized in the accompanying tables. The output in 1914 was 10,389,072 barrels against 10,819,521 barrels in the preceding year; showing a decrease of 430,449 barrels or approximately 4 per cent. Converted to a tonnage basis, the product last year was equivalent to 1,454,470 short tons. It was the third largest total that has been reported up to the present.

The classification of the product according to grades recognized in the trade is followed so far as practicable without revealing the individual figures. Rock salt and the salt in brine that is consumed for alkali manufacture appear in the last item of the tables, which includes also small amounts of evaporated salt not specially classified in the returns. Most of the evaporated salt is marketed under the grades of common fine, common coarse, table and dairy, solar and packers salt. Table and dairy salt includes the superior grades of artificially evaporated salt that are specially prepared for the table and for butter and cheese making; it brings the highest market prices. Under common fine are listed the other grades of fine, artificially evaporated salt that are not specially prepared. Common coarse represents the coarser product from artificial evaporation. Solar salt is made by evaporation of brine in shallow vats exposed to the sun's heat. The process is employed only by the manufacturers on the old Onondaga Salt Springs Reservation at

Syracuse, and can be carried on of course only in the summer months. The product is used practically for the same purposes as rock salt. Packers salt includes the grade sold to meat packers and fish salters.

Production of salt by grades in 1913

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine ¹	I 490 957	\$583 757	\$.39
Common coarse.....	III 057	45 942	.45
Table and dairy.....	I 266 864	789 857	.62
Solar.....	436 800	131 040	.30
Packers.....	107 293	51 895	.48
Other grades ²	7 406 550	I 254 173	.17
Total.....	10 819 521	\$2 856 664	\$.26

¹ Common fine includes a small quantity of common coarse.

² Includes rock salt, salt in brine used for alkali manufacture, and small amounts of brine salt for which the uses were not specified in the returns.

Production of salt by grades in 1914

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine ¹	I 369 071	\$543 203	\$.40
Common coarse.....	162 329	74 545	.46
Table and dairy.....	I 272 629	820 840	.64
Solar.....	328 700	90 392	.27
Packers.....	100 186	50 402	.50
Other grades ²	7 156 157	I 256 324	.18
Total.....	10 389 072	\$2 835 706	\$.27

¹ Common fine includes a small amount of common coarse.

² Includes rock salt, salt in brine used for alkali manufacture, agricultural salt, and small amounts of brine salt for which the uses were not specified in the returns.

The production in recent years has come from a number of localities comprised within the counties of Genesee, Livingston, Onondaga, Schuyler, Tompkins and Wyoming. Altogether the brine salt industry is the larger and includes the following list of manufacturers now active: International Salt Co., with works at Myers and Watkins; Worcester Salt Co., Silver Springs; Eureka Salt Corporation, Saltville; Rock Glen Salt Co., Rock Glen; Remington Salt Co., Ithaca; Watkins Salt Co., Watkins; Genesee Salt Co., Piffard; Le Roy Salt Co., Leroy; and the several makers of solar salt at Syracuse who market their output through the Onondaga Coarse Salt Association of that city. To the list may be

added the Solvay Process Co. which produces a large amount of brine but use it all in soda manufacture. There are two rock salt mines, of which one is owned by the Retsof Mining Co. of Retsof, and the other is worked by the Sterling Salt Co. of Cuylerville.

The salt deposits of the State are very extensive and capable of supporting any demand that may be made upon them. They are found to the south of the outcrop of the Salina formation of which they are a part, in the section from Madison county to Erie county. It is unusual to find them at depths of less than 800-1000 feet, since the portions above that limit have been dissolved away, but they have been penetrated in wells far to the south of the outcrop at depths of 3000 feet and over. New beds are discovered from time to time in course of explorations for oil and gas.

A complete record of the industry is available since 1797 when the first regular operations were started on the Onondaga reservation. The total output from that time down to and including the year 1914 has been 268,011,788 barrels. The annual production for the last 25 years has been as follows:

Production of salt in New York since 1890

YEAR	BARRELS	VALUE
1890.....	2 532 036	\$1 266 018
1891.....	2 839 544	1 340 036
1892.....	3 472 073	1 662 816
1893.....	5 662 074	1 870 084
1894.....	6 270 588	1 999 146
1895.....	6 832 331	1 943 398
1896.....	6 069 040	1 896 681
1897.....	6 805 854	1 948 759
1898.....	6 791 798	2 369 323
1899.....	7 489 105	2 540 426
1900.....	7 897 071	2 171 418
1901.....	7 286 320	2 089 834
1902.....	8 523 389	1 938 539
1903.....	8 170 648	2 007 807
1904.....	8 724 768	2 102 748
1905.....	8 575 649	2 303 067
1906.....	9 013 993	2 131 650
1907.....	9 657 543	2 449 178
1908.....	9 005 311	2 136 736
1909.....	9 880 618	2 298 652
1910.....	10 270 273	2 258 292
1911.....	10 082 656	2 191 485
1912.....	10 502 214	2 597 260
1913.....	10 819 521	2 856 664
1914.....	10 389 072	2 835 706

SAND AND GRAVEL

The production of sand and gravel should be given consideration as one of the branches of the mineral industry. It is carried on in one or more places in practically every county of the State; but only in a few sections has it become really stabilized so as to be conducted on a more or less permanent basis. For that reason a statistical investigation of the industry is attended with considerable difficulty, and the results may be lacking somewhat in accuracy.

Such is the case more especially with the ordinary building sands and gravels which are so widely distributed that in most places they have little or no intrinsic value, the requirements being supplied from deposits in the immediate vicinity at a nominal expense above the cost of handling. In recent years, however, there has been a manifest tendency toward a standardization of these materials where they are to be employed in important structures or engineering works. It has been found that they have a very direct influence upon the quality of the mortar or concrete into which they enter, a fact that has not received so wide appreciation as it should perhaps, outside of the engineering profession. The need for materials that will meet the modern requirements has made necessary more care in the selection, besides preparation oftentimes by sizing or washing. This development is one that promises to place the industry upon a more settled basis than it has had in the past.

Sand also serves a variety of other uses, such as for glass manufacture, for making of molds for casting metals, as an abrasive, and in numerous manufacturing and metallurgical operations. In most of these applications the sands must meet certain definite requirements as to physical condition, mineral or chemical composition, which greatly limit the available sources of supply. Their production necessitates a degree of skill and technic which makes for permanency in the enterprises.

The sand and gravel beds of the State belong mainly to the Pleistocene formations, accumulated as the result of the great ice invasion which moved from north to south and reached as far south as northern New Jersey and Pennsylvania. This ice sheet swept the rocks bare of their former mantle of disintegrated materials and in their place left a covering of transported boulders, gravels, sands and clays. These materials when deposited directly by the ice as ground moraine are so intermixed as to have little or no industrial value. Such unmodified drift covers a considerable portion of the area, especially in the hilly country, whereas in the

valleys and lowlands it is usually concealed by beds of sorted gravels, sands and clays. These latter were deposited by the waters which issued from the glacier during its retreat. In some of the larger valleys, as those of the Hudson, Champlain and Genesee, as well as in numerous smaller ones, the glacial waters were held imprisoned for a time by dams so that they stood high above the present levels, and the sands and clays were deposited in a series of terraces in great thickness and in well-sorted arrangement.

Beach sands are found on the shores of Long Island and Staten Island and of some of the interior lakes, notably Oneida lake. These are characterized by a degree of uniformity and purity which make them valuable for many purposes. The sands that have been used most extensively for glass making are found on Oneida lake.

Production. The statistics of the sand and gravel industry, as collected from the individual producers, give an approximation of the total business, but it is not claimed that they are complete. The figures for molding sand, however, are complete, as this branch of the industry is conducted on a settled basis which admits of an accurate canvass. The figures of building sand and gravel no doubt underestimate the actual production, perhaps by as much as 15 per cent. The operations are so widely scattered and in many places of so fugitive a nature that they can not all be included in the canvass.

Production of sand and gravel

MATERIAL	1912	1913	1914
Building sand.....	\$1 156 002	\$1 102 688	^a \$1 151 521
Molding sand.....	422 148	449 224	310 727
Fire and core sand.....	55 910	38 571	23 944
Other sand ^b	75 000	75 000	75 000
Gravel.....	840 669	918 783	650 895
Total.....	\$2 549 729	\$2 584 266	\$2 212 087

^a Includes filter sand.

^b Includes glass sand, filter sand except for 1914, engine sand, polishing sand and core sand.

Building sand. The main uses of this sand are for concrete and mortar. It is produced in about every community of any importance, inasmuch as almost any sandy material which is not too diluted with mud or silt may be employed for some of the purposes for which building sand is used. The more extensive

workings are in the vicinity of New York, Buffalo and Rochester. New York derives its principal supply from the beach sands on the north shore of Long Island, mainly from Nassau county. They are dredged from shallow water and conveyed to market in barges. They are among the best sands of their type, consisting of nearly pure quartz sand, well sorted and fairly coarse. Buffalo is supplied from the beach sands of Lake Erie. Glacial sands, modified by stream action, are the sources of supply in Albany and Rochester and many of the interior towns.

The output of building sand in 1914 was returned as 3,710,796 cubic yards worth \$1,151,521, about the same as was reported in the two previous years. The output, however, included some filter sand which previously was listed under another head.

Molding sand. The production of molding sand was 310,727 short tons valued at \$310,727, showing a large decrease for the year. The falling off was the result of the depression in the metal trades which curtailed the market. This grade of sand is produced in a single district which includes the section along the Hudson river from Saratoga and Washington counties on the north to Kingston, Ulster county. The sand is a deposit formed in the glacial Lake Albany, that has been sorted by wind action and modified by weathering influences. The main production comes from the terraced lands just north and south of Albany. The industry is represented by a relatively few companies and individuals who maintain continuous operations from year to year. The sand is remarkable for its fine, even grain.

SAND-LIME BRICK

The manufacture of sand-lime brick was carried on last year by three plants, one less than in 1913. The companies represented were the Paragon Plaster Co. of Syracuse, the Buffalo Composite Brick Co. of Buffalo, and the Rochester Composite Brick Co. of Rochester, all of which have been in the business for several years. The Glens Falls Granite Brick Co., the first to erect a plant in the State for commercial production, did not operate during the past season.

The production for the year amounted to 17,696,000, valued at \$111,326, against 22,225,000, valued at \$143,345 in 1913. The average selling price was \$6.29 a thousand as compared with \$6.40 in the preceding year.

Although the industry has not shown the growth that was earlier

predicted by those interested in its development, it has established a recognized place for its products among standard building materials. It was handicapped for a time by the sales of inferior grades of brick, made in plants which were not properly equipped for turning out a first-class product. Some of these brick had a mortar bond and should not have been classed as sand-lime brick. It can be definitely stated that such grades are no longer manufactured, and that the present output consists of a superior grade with a calcium silicate bond.

Production of sand-lime brick

YEAR	QUANTITY	VALUE	VALUE A THOUSAND	OPERAT- ING PLANTS
1906.....	17 080 000	\$122 340	\$7 16	7
1907.....	16 610 000	109 677	6 60	9
1908.....	8 239 000	55 688	6 44	6
1909.....	12 683 000	81 693	6 31	6
1910.....	14 053 000	82 619	5 88	6
1911.....	15 178 000	92 064	6 05	5
1912.....	21 231 000	133 736	6 30	5
1913.....	22 225 000	143 345	6 40	4
1914.....	17 696 000	111 326	6 29	3

STONE

The products of the stone quarries form a large item in the total mineral production of the State. The last few years have witnessed, however, some notable changes in the relative importance of the different branches of the stone industry. The use of cement and terra cotta in architectural work has curtailed the demand for cut stone, so that this branch no longer occupies the prominent place that it once had. Similarly the market for flagstone and curbstone has fallen off, especially for flagstone, as a result of the favor shown for cement construction. On the other hand there has been a tremendous development of the crushed stone industry, which has practically counterbalanced the declines in the other departments. Altogether the changes that have taken place have meant a loss industrially, since the preparation of crushed stone requires a minimum of labor of the unskilled sort, while the cut stone business once gave employment to large numbers of highly trained workmen.

The statistics of stone production which have been supplied by the quarry operators throughout the State indicate that the year

1914 was a period of great depression for all branches of the industry. As compared with the conditions in the preceding year, which may be described as about normal, the past season represented a reaction of extreme character such as has not been experienced in a long time. The actual decline of output was 17 per cent, from a value of \$6,763,054 in 1913 to \$5,741,137 last year, but these figures scarcely indicate the full extent of the depression since the worst stage was not reached until the late months. Many quarries closed down in the late summer and fall and have not since resumed work. There is little expectation that the trade will show much improvement during the current season.

The granite quarries reported a slight gain in the value of their output which was the result of sales of cut stone for buildings and a small gain in crushed stone. The other products, inclusive of monumental granite, showed a decline.

Limestone, as heretofore, constituted somewhat more than one-half of the total output in value, although there was a very large decrease in the aggregate. The falling off was distributed over all the various branches, including building stone, crushed stone, lime and flux.

The production of the marble quarries showed little change. A small increase in building stone was counterbalanced by a diminished output of monumental stock.

The sandstone quarries were worked on a much diminished scale, the decline being greater in this industry than in any other of the stone trades. The depression was felt by both the bluestone quarries and those of ordinary sandstone, and their production was smaller than in any previous year for a long time.

The trap quarries in the palisades region contributed a reduced output of crushed stone.

The production of the different kinds of stone for the last three years is shown in the accompanying tables.

Production of stone in 1912

VARIETY	BUILD- ING STONE	MONU- MENTAL	CURBING AND FLAG- GING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite.....	\$65 487	\$19 130	<i>a</i>	\$49 307	\$68 172	\$202 096
Limestone.	108 581	.....	\$5 481	2 176 368	1 220 015	3 510 445
Marble.....	155 411	84 511	.....	.....	1 925	241 847
Sandstone.....	363 055	.....	615 846	45 301	256 541	1 280 743
Trap.....	.....	.....	.....	483 863	.....	483 863
Total.....	\$692 534	\$103 641	\$621 327	\$2 754 839	\$1 546 653	\$5 718 994

a Included under "All other."

Production of stone in 1913

VARIETY	BUILD- ING STONE	MONU- MENTAL	CURBING AND FLAG- GING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite.....	\$45 911	\$17 013	<i>a</i>	\$236 650	\$36 068	\$335 642
Limestone.....	101 198	.....	\$6 546	2 386 632	1 358 302	3 852 678
Marble.....	127 556	81 330	.....	.....	43 406	252 292
Sandstone.....	285 645	.....	682 984	46 267	306 376	1 321 272
Trap.....	.....	.....	.....	1 001 170	.....	1 001 170
Total.....	\$560 310	\$98 343	\$689 530	\$3 670 719	\$1 744 152	\$6 763 054

a Included under "All other."

Production of stone in 1914

VARIETY	BUILD- ING STONE	MONU- MENTAL	CURBING AND FLAG- GING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite.....	\$79 903	\$10 952	.....	\$259 750	\$16 637	\$367 242
Limestone.....	81 409	.....	\$3 877	2 156 503	1 074 274	3 316 063
Marble.....	142 223	70 797	.....	8 000	9 222	230 242
Sandstone.....	217 508	.....	490 222	36 143	313 117	1 056 990
Trap.....	.....	.....	.....	770 660	.....	770 600
Total.....	\$521 043	\$81 749	\$494 099	\$3 231 056	\$1 413 250	\$5 741 137

GRANITE

Granite is both a specific and a general term. When used in the restricted scientific sense it means an igneous rock of thoroughly crystalline character in which the chief constituents are feldspar, quartz and mica. Such a rock has a massive appearance; that is, the constituents are uniformly distributed in every direction, and owing to the predominance of the feldspar and quartz the color is rather light, commonly gray or pink. As a variation to the uniform distribution of the minerals, the latter may develop a plane parallel arrangement through the influence of compression when the mass was still deeply buried in the earth's crust. A granite with this parallel or foliated texture is known as a granite gneiss.

The commercial definition of granite is much broader than that given and includes almost any of the crystalline silicate rocks (usually igneous) that possess the requisite physical qualities for use as architectural or monumental stone. In most cases the commercial product is actually a granite in the true sense, but not infrequently it may be a syenite which lacks quartz, or a diorite consisting of plagioclase, feldspar and hornblende, or anorthosite which contains little else than basic plagioclase feldspar. So-called black granites are mainly gabbros and diabases with a large proportion of the iron compounds pyroxene, hornblende and magnetite.

The broader usage will be followed in the present classification, as all the above-named rocks are quarried in this State. The only silicate rock not included under granite is diabase or trap which, on account of the special features surrounding its production and uses, is classified by itself.

Granites and the related igneous types are restricted to two well-defined areas in New York — the Adirondacks in the north and the Highlands in the southeast. Some account of the principal quarries in the two areas has been given in the issue of this report for the year 1911.

The production of granite in the last three years is given in the table herewith. The figures represent the commercial value of the output of all the quarries, with the exception of those operated by contractors on road improvement work, for which it is difficult to compile any reliable figures. The total value of the granite quarried in 1914 was \$367,242, as compared with \$335,642 in 1913. Gains in building and crushed stone were reported but decreases in the other kinds.

Production of granite

VARIETY	1912	1913	1914
Building.....	\$65 487	\$45 911	\$79 903
Monumental.....	19 130	17 013	10 952
Crushed stone.....	49 307	236 650	259 750
Rubble, riprap.....	27 861	9 722	.....
Other kinds.....	40 311	26 346	16 637
Total.....	\$202 096	\$335 642	\$367 242

LIMESTONE

The stone classified under the heading of limestone consists for the most part of the common grades of limestone and dolomite, such as are characterized by a compact granular or finely crystalline texture and are lacking in ornamental qualities.

A smaller part is represented by crystalline limestone and by the waste products of marble quarrying which are sometimes employed for crushed stone, lime-making or flux. Limestone used for the manufacture of portland and natural cement is, however, excluded from the tabulations so as to avoid any duplications of the statistics.

Limestones have a wide distribution in the State, the only region which is not well supplied being the southern part where the prevailing formations are sandstones of Devonian age. The microcrystalline varieties occur in regular stratified order in the Cambrian, Lower Silurian, Upper Silurian and Devonian systems. In most sections they occupy considerable belts and have been little disturbed from their original horizontal position. On the borders of the Adirondacks and in the metamorphosed Hudson river region, however, they have been more or less broken up by faulting and erosion and in places have a very patchy distribution.

The Cambrian limestones are found in isolated areas on the east, south and west of the Adirondacks. They are usually impure, representing a transition phase between the Potsdam sandstones below and the high calcium limestones above. The lower beds of the Beekmantown formation as originally defined are now known to belong to the Cambrian system. The Little Falls dolomite is perhaps the most prominent member of the Cambrian limestones and is extensively developed in the Mohawk valley with quarries at Little

Falls, Amsterdam, and other places. It is a rather heavily bedded stone of grayish color, suitable more especially for building purposes. In Saratoga county the Hoyt limestone is in part the equivalent of the Little Falls dolomite; it has been quarried for building stone just west of Saratoga Springs. On the west side of the Adirondacks the Theresa limestone is described by Cushing as a sandy dolomite which may in part belong to the Cambrian system. It is comparatively thin and has no importance for quarry purposes.

The Beekmantown limestone, which is now taken as including the middle and upper beds of that series as earlier defined, is mostly restricted to the Champlain valley. It occurs on the New York shore in rather small areas, usually down-faulted blocks, that are the remnants of a once continuous belt. It is also represented doubtless in the basal portion of the limestone area that extends across Washington and Warren counties. The only place where it has been extensively quarried is at Port Henry where the purer layers have been worked for flux. In the Lake Champlain region it is a bluish or grayish magnesian limestone occurring in layers from a few inches to several feet thick.

The Chazy limestone is found in the same region as the Beekmantown in discontinuous areas along the eastern Adirondacks from Saratoga county north to the Canadian boundary. It attains its maximum thickness in eastern and northeastern Clinton county, and has been quarried around Plattsburg, Chazy and on Valcour island. The Chazy is the earliest representative of the Paleozoic formations characterized by a fairly uniform high calcium content; it analyzes 95 per cent or more of calcium carbonate. It has a grayish color and finely crystalline texture. The fossiliferous beds afford attractive polished material which is sold as "Lepanto" marble. It is used also for lime and furnace flux. There are old quarries on Willsboro point, Essex county. On the west side of the Adirondacks the Pamela limestone, described in the areal reports of that section, belongs to the Chazy series. It covers a considerable area in Jefferson county between Leraysville and Clayton, and has been rather extensively quarried for building stone and lime, though of subordinate importance to the Trenton limestones of that section.

In the Mohawkian or Trenton group are included the Lowville (Birdseye), Black River and Trenton limestones which have a wide distribution and collectively rank among the very important quarry materials of the State. They are represented in the Champlain valley but are specially prominent on the Vermont side; from

the latter area a belt extends southwest across northern Washington county to Glens Falls in Warren county and is continued into Saratoga county. Another belt begins in the Mohawk valley near Little Falls and extends northwesterly with gradually increasing width across Oneida, Lewis and Jefferson counties to the St Lawrence river. There are isolated areas of Trenton limestone in the Hudson valley south of Albany. The limestones vary in composition and physical character according to locality and geologic position. They are often highly fossiliferous. In the northern section they are mostly gray to nearly black in color, contain little magnesia and run as high as 97 or 98 per cent calcium carbonate. The lower part of the group is heavily bedded and well adapted for building stone; the upper beds commonly contain more or less shale. They are used for various purposes including building and ornamental stone, crushed stone, lime, portland cement and flux. In the Champlain valley quarries are found near Plattsburg, Larabee's Point and Crown Point; in Washington county at Smith's Basin; in Warren county at Glens Falls where there are extensive quarries that supply material for building purposes, portland cement and lime. The well-known black marble from Glens Falls is taken from the Trenton. Numerous quarries have been opened in Herkimer, Oneida, Lewis and Jefferson counties. The output of the last named county is specially important, including limestone for building and road construction and lime for manufacture of calcium carbide. The principal quarries in Jefferson county are at Chaumont.

The next assemblage of limestones in the order of stratigraphic occurrence includes the Clinton, Lockport and Guelph members of the Niagara group. The Clinton limestone has a variable importance in the belt of Clinton strata that extends from Otsego county a little south of the Mohawk river across the central and western parts of the State on the line of Oneida lake and Rochester to the Niagara river. East of Rochester the limestone is relatively thin, usually shaly and split up into several layers, but on the west end in Niagara county it becomes the predominant member and has a more uniform character. Large quarries have been opened recently at Pekin, Niagara county, for the supply of flux to the blast furnaces of the Lackawanna Steel Co., at Buffalo. The upper beds of bluish gray fossiliferous limestone from 10 to 12 feet thick are the purest and analyze from 90 to 95 per cent. calcium carbonate. The Lockport is a magnesian limestone, in places a typical dolomite, and is rather siliceous in the lower part. It outcrops in a continuous belt,

several miles wide, from Niagara Falls east to Onondaga county and then with diminishing width across Madison county. The upper layers are rather heavy and yield material suitable for building purposes, road metal and lime. There are quarries around Niagara Falls, Lockport and Rochester. It is worked to some extent in Wayne, Onondaga and Madison counties. The Guelph, also a dolomite, occupies a limited area in Monroe and Orleans counties and is worked near Rochester.

The Cayugan group includes among its members the Cobleskill, Rondout and Manlius limestones, which are economically important. They have furnished large quantities of material for the manufacture of natural cement, being the source of the cement rock in the Rosendale district and in Schoharie and Onondaga counties. The cement rock of Erie county is found in the Salina formation. The Manlius limestone is used for portland cement in the eastern part of the State.

At the base of the Devonian system appears the Helderbergian group which is very important for its calcareous strata. Limestones of this age are strongly developed along the Hudson river in Albany, Columbia, Greene and Ulster counties. The Coeymans or lower Pentamerus and the Becraft or upper Pentamerus limestones afford material for building, road metal, lime and portland cement. The limestone for the portland cement works at Hudson and Greenport is obtained from Becraft mountain, an isolated area of limestones belonging to the Manlius, Helderbergian and Onondaga formations. The works at Howes Cave use both the Manlius and Coeymans limestones. Extensive quarries are located also at Catskill, Rondout and South Bethlehem.

The Onondaga limestone, separated from the preceding by the Oriskany sandstone, has a very wide distribution, outcropping almost continuously from Buffalo, Erie county, eastward to Oneida county and then southeasterly into Albany county, where the belt curves to the south and continues through Greene, Ulster and Orange counties to the Delaware river. It is in most places a bluish gray, massive limestone with layers and disseminated nodules of chert. The chert is usually more abundant in the upper beds. The limestone finds use as building stone and the less siliceous materials also, for lime-making. Quarries have been opened at Kingston, Split Rock (near Syracuse), Auburn, Waterloo, Seneca Falls, Le Roy, Buffalo and other places.

The Tully is the uppermost of the important limestone formations and likewise the most southerly one represented in the central part

of the State. Its line of outcrop extends from Ontario to Madison county, intersecting most of the Finger lakes. Its thickness is not over 10 feet, and on that account can not be worked to advantage except under most favorable conditions of exposure. For building stone it is quarried only locally and to a very limited extent. It finds its principal use in portland cement manufacture, being employed for that purpose by the Cayuga Lake Cement Co., in its works at Portland Point, Tompkins county.

Marl is a useful substitute for the hard limestone for some purposes and is rather extensively developed in the central and western parts of the State. It is found particularly in swampy tracts and old lake basins associated with clay and peat. In the Cowaselon swamp near Canastota the marl underlies several thousand acres and is said to be 30 feet thick. The Montezuma marshes in Cayuga and Seneca counties contain a large deposit which at Montezuma is 14 feet thick. In Steuben county the marls at Arkport and Dansville have been employed for lime-making. Until recently marls have been used extensively for portland cement and plants were operated at one time in the marl beds near Warner and Jordan, Onondaga county; at Montezuma, Cayuga county; Wayland, Steuben county; and Caledonia, Livingston county. Their principal use at present is for agricultural and chemical purposes.

Production. As already noted in a previous paragraph, limestone ranks first in importance among the quarry materials of the State. The value of the output is larger than that of all other kinds together, and is gaining in relative importance year by year. Its main use is for crushed stone for concrete and roadwork; most of the stratified formations contain limestones that are adapted to that purpose. It is also employed as building stone, though not so extensively as formerly, and considerable quantities are consumed in metallurgy and chemical manufacturing. Of late quite a demand for finely ground limestone has developed in connection with agriculture. Lime manufacture still holds a prominent place in the industry.

The production of limestone, after showing a steady gain for several years, fell off markedly in 1914 and aggregated only \$3,316,063 as compared with \$3,852,678 in 1913. The decline amounted to about 14 per cent. The figures for the last three years distributed according to the various uses are shown herewith.

Production of limestone

MATERIAL	1912	1913	1914
Crushed stone.....	\$2 176 368	\$2 386 632	\$2 156 503
Lime made.....	452 002	486 908	370 377
Building stone.....	108 581	101 198	81 409
Furnace flux.....	542 154	575 102	446 877
Rubble, riprap.....	10 696	26 006	6 055
Flagging, curbing.....	5 481	6 546	3 877
Miscellaneous.....	215 163	270 286	250 965
Total.....	\$3 510 445	\$3 852 678	\$3 316 063

Altogether 91 quarries reported an output, as compared with 104 in 1913. There were 29 counties represented in the industry. There were no new quarries of any importance opened during the year.

Erie county outranks all others in importance in this industry; the value of the limestone quarried in the county last year amounted to \$704,865. The products are chiefly furnace flux, crushed stone and building stone. The principal quarries are at North Buffalo, Clarence and Akron.

Onondaga county is the second largest producer, having an output last year valued at \$385,335. Crushed stone is a large item in its industry, and most of the remainder consists of limestone quarried by the Solvay Process Co. for use as a reagent in alkali manufacture.

The other counties reporting values of over \$100,000 in 1913 were Dutchess, Ulster, Niagara, Rockland, Genesee, Warren, Schoharie, Clinton and Albany counties, named in the order of their output.

Crushed stone. Limestone is crushed for road metal, railroad ballast and for concrete. The larger quarries supplying this material are in Erie, Genesee, Onondaga, Dutchess, Ulster, Rockland and Westchester counties. The fines from some of the quarries are sold for agricultural use, the sales being entered under "other uses." The value of the crushed stone for 1914 showed a decrease due to the smaller demand in the building trade, and totaled \$2,156,503, against \$2,386,632 in the preceding year. The total does not include stone crushed by contractors on the highway system, but the value of such stone is relatively small. The actual

quantity of stone produced by the crushing plants was 3,306,325 cubic yards against 3,945,543 cubic yards in 1913.

Lime. The value of the lime made for market last year was \$370,377, as compared with \$486,908 in 1913. In quantity it amounted to 82,944 short tons, against 110,083 short tons in 1912. The decrease was brought about mainly by the shutting down of two of the larger plants, one in Lewis and another in Genesee counties. Although less lime is used in the building trade than formerly, the loss has been partially compensated by the growth of demand in the agricultural industry. The principal plants are in Warren, Washington, Clinton, Fulton, Madison and Dutchess counties.

Building stone. The production of building stone has fallen off year by year, so that a further decrease in 1914 was not unexpected. The decline of 20 per cent, however, was larger than usual and reduced the output so that it represented but a fraction of the former total. The returns showed the value of the building stone to be \$81,409 as compared with \$101,198 in 1913. This represents less than one-third of the output ten years ago.

The diminished demand for cut stone is a feature that has manifested itself in the building trades throughout the country. It is due largely to change in the methods of building construction, particularly in the use of steel, concrete and tile for large structures. The principal quarries of building stone are in Erie, Cayuga, Onondaga and Montgomery counties.

Furnace flux. The metallurgical establishments, especially the iron and steel plants, consume a large quantity of fluxing limestone which is obtained mostly from local resources. For this purpose calcium limestone is mostly in demand, and it is required to be nearly free of siliceous and aluminous impurities. The principal flux quarries are in the Onondaga limestone of Erie and Genesee counties, the Clinton limestone of Niagara county, the Precambrian limestones or marbles of the Adirondacks and the Chazy limestone of the Champlain valley. The limestones in these sections ordinarily carry from 90 to 95 per cent of calcium carbonate. The production of flux in 1914 was valued at \$446,877, representing a total of 795,538 net tons, as compared with \$575,102 and 1,052,519 tons in 1913. Niagara and Erie counties, which supply the iron and steel works around Buffalo, reported the largest quantities.

Agricultural lime. The use of lime on soils has become in the last few years an important factor in the quarry industry. The quantity sold for the purpose is not given separately in the statisti-

cal tables, for the reason that many of the quarry companies do not themselves know the amount of the product that is thus used. Some of the material disposed of for agricultural use is really a by-product of which little account is taken, as in the case of the fines and dust of the crushing plants which are sometimes marketed, and also the inferior grades of quicklime. There are a number of quarries, however, that make a specialty of this trade, selling all or a large part of their product for agricultural use. It is estimated that fully 100,000 tons of limestone were thus marketed by the quarries, and the amount may have been considerably more.

The possibilities of the trade have received much attention in the last few years, and quarry lands favorably situated with respect to the markets have been in request. Inasmuch as the material must be delivered to the consumer at a low cost to make it economically available, the tendency is to develop local sources of supply in so far as these are available.

The resources in limestone suitable for agricultural use are quite widespread, but they are not always within easy reach of markets. They are most abundant in the northern section particularly on the borders of the Adirondacks and the adjacent regions to the south, where they occur in the Precambrian and early Paleozoic formations. The crystalline limestones or marbles of St Lawrence, Jefferson and Lewis counties and the Trenton and Chazy stratified limestones of the Champlain and Mohawk valleys are among the best high calcium rocks. Some agronomists hold the view that magnesium above a small amount is detrimental, while others are of the opinion that it may perform a useful function or at least have no harmful effect if not existing in a proportion of more than about one-half that of lime. Supplies of magnesian limestones occur in Highlands and Taconic sections and also in the central and western counties. The southern tiers of counties on the Pennsylvania border are devoid of carbonate rocks.

Production of limestone by counties in 1913

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILD- ING STONE	OTHER USES	TOTAL
Albany.....	\$141 583					\$141 583
Cayuga.....	30 455			\$12 552	\$74	43 081
Clinton.....	42 861	\$62 073	\$17 810	450	1 255	124 449
Dutchess.....	433 117	18 392				451 509
Erie.....	514 619		251 011	56 239	10 710	832 579
Genesee.....	208 881	15 000	60 860	700	3 500	288 941
Greene.....	2 300				350	2 650
Herkimer.....	1 800					1 800
Jefferson.....	8 170	58 230	1 000		16 400	83 800
Lewis.....	11 971	43 602		114	4 471	60 158
Madison.....	43 365	41 571	1 380	685	1 950	88 951
Monroe.....	30 695	7 650		5 199		43 544
Montgomery.....	30 949			4 995	1 361	39 305
Niagara.....	22 396		215 498	2 810	236	240 940
Onondaga.....	282 425			9 581	209 500	501 506
St Lawrence.....	13 407	3 162	18 915	810	453	36 747
Schoharie.....	86 742		400	431	26 438	114 011
Ulster.....	76 071	16 010				92 081
Warren.....	32 466	154 618		5 435	26 082	218 601
Washington.....	1 500	43 000		250		44 750
Other counties....	370 859	23 600	8 228	947	58	403 692
Total.....	\$2 386 632	\$486 908	\$575 102	\$101 198	\$302 838	\$3 852 678

Production of limestone by counties in 1914

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILD- ING STONE	OTHER USES	TOTAL
Albany.....	\$101 022					\$101 022
Cayuga.....	49 860			\$14 124		63 984
Clinton.....	14 917	\$61 462	\$12 423	3 500	\$10 616	102 918
Dutchess.....	322 970	26 050				349 020
Erie.....	478 127		177 764	44 939	4 035	704 865
Genesee.....	156 302		40 000	600		196 902
Greene.....	4 039					4 039
Herkimer.....	700					700
Jefferson.....	10 992	11 600			2 700	25 292
Lewis.....	3 700			217		3 917
Madison.....	43 498	55 896				99 394
Monroe.....	20 027	4 898		1 021		25 946
Montgomery.....	6 400			4 576	744	11 720
Niagara.....	6 780		190 334	300	5 700	203 114
Oneida.....	74 741					74 741
Onondaga.....	148 106			6 193	231 036	385 335
St Lawrence.....	3 937	4 500	22 172	2 440	274	33 323
Schoharie.....	108 241			416		108 657
Ulster.....	208 720	7 740				216 460
Warren.....	18 406	129 281		1 708	5 343	154 738
Washington.....		40 000		1 000		41 000
Other counties....	375 018	28 950	4 184	375	449	408 976
Total.....	\$2 156 503	\$370 377	\$446 877	\$81 407	\$260 807	\$3 316 063

MARBLE

Marble, in the commercial sense, like granite, includes a variety of rocks that lend themselves to building or decorative uses. Most commonly, the name signifies a crystalline aggregate of calcite or dolomite, as distinguished from ordinary limestones which at best are of indistinctly crystalline nature. At the same time it implies the feature of attractiveness by reason of color and the ability to take a lustrous polish. Rocks possessing all these features are marbles in the strict sense to which the name may be applied without qualification. Some compact or granular limestones that lack the elements of thorough crystallinity make, however, a handsome appearance when polished, and such are commercially classed as marbles. Fossil marbles, black marbles, and a few other kinds are commonly of the noncrystalline type. Serpentine marble, or verde antique, is made up for the most part of the mineral serpentine, a silicate of magnesium and iron, and is therefore not related to the varieties already described. Ophitic limestone, or ophicalcite, is a crystalline limestone or dolomite carrying grains and nodules of serpentine scattered more or less evenly through its mass. Its ornamental quality lies in the speckled or mottled pattern and the sharp contrast between the clear white mass and the greenish serpentine inclusions.

Marbles belonging to those various types find representation in the geologic formations of the State and are quarried on a commercial scale or have been so quarried in the past.

The true or crystalline varieties are limited in occurrence to the metamorphic areas of the Adirondacks and southeastern New York. They are of early geologic age, antedating the period of crustal disturbance and metamorphism which in the Adirondacks was brought to a close practically before Cambrian time and which in southeastern New York was completed in the Paleozoic. This thoroughly crystalline character is in fact a development of the strong compression accompanied by heat to which they have been subjected; having been originally, no doubt, ordinary granular or fossiliferous limestones similar to those so plentifully represented in the undisturbed formations outside the regions.

The crystalline limestones of the Adirondacks are most abundant on the western border in Jefferson, Lewis and St Lawrence counties where they occur in belts up to 4 or 5 miles wide and several times as long, interfolded and more or less intermixed with sedimentary gneisses, schists and quartzites. They are found in smaller and more irregularly banded areas in Warren and Essex counties on the

eastern side, but have little importance elsewhere. The ophitic limestones that have been quarried at different times belong to the same series. The marbles of the Adirondacks comprise both the calcite class with very little magnesia and the dolomite class containing high percentages of magnesia. No definite relation is apparent in regard to the occurrence of the two and both may be found in the same area and in close association.

The southeastern New York marbles occur in belts which follow the north-south valleys, east of the Hudson, from Manhattan island into Westchester, Dutchess and Columbia counties. They range from very coarsely crystalline to finely crystalline rocks, are pre-vaillingly white in color and belong to the dolomite class. They are interfolded with schists and quartzites, the whole series having steep dips like those of strongly compressed strata. The geologic age of the southern belts is probably Precambric, but on the north and east within range of the Taconic disturbance, they may belong to the early Paleozoic.

Bodies of practically pure serpentine of considerable extent are found on Staten Island and in Westchester county near Rye; they represent intrusions of basic igneous rocks whose minerals, chiefly pyroxene and olivine, have subsequently changed to serpentine. They are not important for quarry purposes, owing to the frequency of fissures and joints and the rather somber color of the exposed part of the masses.

The microcrystalline or subcrystalline limestones that are sometimes sold as marbles include members of the regularly bedded unmetamorphosed Paleozoic limestones, which locally show qualities of color and polish that make them desirable for decorative purposes. They range from dense granular varieties to those having a more or less well-developed crystalline texture and are often fossiliferous. Inasmuch as they have never been subjected to regional compression or been buried in the earth deep enough to become heated, the crystalline texture, when present, may be ascribed to the work of ground waters. These circulate through the mass, taking the carbonates of lime and magnesia into solution, and redeposit them in crystalline form. Originally, the limestones were accumulations of lime-secreting fossils or granular precipitates, for the most part of marine origin. Some of the localities where these unmetamorphic marbles occur are on the west shore of Lake Champlain, around Plattsburg and Chazy (Chazy limestone), Glens Falls (Trenton limestone) and Becraft and Catskill (Becraft limestone).

Production. Building and other kinds of marble to the value of \$230,242 was quarried in 1914, showing a slight decrease of production as compared with the preceding year. The active quarries were situated in Clinton, Warren, St Lawrence, Dutchess and Westchester counties. Most of the building marble came from the quarries of the South Dover Marble Co. at Wingdale, Dutchess county. The quarries at Gouverneur, including those of the St Lawrence, Northern New York and Gouverneur companies, supplied the monumental stock. Black and "shell" marble for decorative work were also quarried, the former by Finch, Pruyn & Co. of Glens Falls and the latter by the Vermont Marble Co., of Proctor, Vt.

Production of marble

VARIETY	1912	1913	1914
Building marble.....	\$155 411	\$127 556	\$142 223
Monumental.....	84 511	81 330	70 797
Other kinds.....	1 925	43 406	17 222
Total.....	\$241 847	\$252 292	\$230 242

SANDSTONE

Under sandstones are included the sedimentary rocks which consist essentially of quartz grains held together by some cementing substance. Among the varieties distinguished by textural features are sandstones proper, conglomerates, grits and quartzites.

Of the sedimentary rocks which occur in the State, sandstone has the largest areal distribution, while in economic importance it ranks second only to limestone. Nearly all the recognized stratigraphic divisions above the Archean contain sandstone at one or more horizons. The kinds chiefly quarried are the Potsdam, Hudson River, Medina and Devonian sandstones. A few quarries have been opened also in the Shawangunk conglomerate and the Clinton and Triassic sandstones.

The Potsdam of the Upper Cambrian is the lowest and earliest in age of the sandstones that have a fairly wide distribution and are utilized for building purposes. The most extensive outcrops are along the northern and northwestern borders of the Adirondacks, in Clinton, Franklin, St Lawrence and Jefferson counties. Other exposures of smaller extent are found in the Lake Champlain valley

and on the southeastern edge of the Adirondack region. These latter areas represent the remnants of a once continuous belt that has been broken up by folding, faulting and erosion. The Potsdam sandstone has in many places the character of a quartzite, consisting of quartz grains cemented by a secondary deposition of quartz, and when is a very hard, tough and durable stone. The quartzite from St Lawrence county has sustained a crushing test of more than 42,000 pounds to the square inch. The color varies from deep red to pink and white. The principal quarries are near Potsdam and Redwood, St Lawrence county, and Malone and Burke, Franklin county. Besides building stone, which is the chief product, there is some flagstone sold, mainly by the quarries at Burke, for shipment to Montreal.

The so-called Hudson river group is essentially a group of sandstones, shales, slates and conglomerates, ranging in age from the Trenton to the Lorraine, but which have not been sufficiently studied to permit the actual delimitation of the various members on the map. The group is exposed in a wide belt along the Hudson from Glens Falls southward into Orange county and also in the Mohawk valleys as far west as Rome. The sandstone beds are usually fine-grained, of grayish color and rather thinly bedded. Over wide stretches they provide practically the only resource in constructional stone and consequently they have been quarried at a great number of places to supply the local needs for building and foundation work. Some of the stone is crushed for road metal and concrete.

The Medina sandstone is found along the southern shore of Lake Ontario from the Niagara river east to Oswego county: in central New York it is represented by a coarse conglomeratic phase called the Oneida conglomerate. As developed in the western part of the State, where it is principally quarried, it is hard fine-grained sandstone of white, pink and variegated color. The pink variety is specially quarried for building stone and has an excellent reputation. Many of the larger cities of the country and most of the important towns and cities of the State contain examples of its architectural use. The large quarries are situated in Orleans county, near Albion, Holley and Medina, along the line of the Erie canal, but there are others at Lockport and Lewiston, in Niagara county and at Brockport and Rochester in Monroe county. The Medina sandstone also finds extensive applications for curbing and flagging and for paving blocks. It is employed more extensively for the latter purpose than any other stone quarried in the State.

The Shawangunk conglomerate is more widely known for its use in millstones than for constructional purposes. It outcrops along Shawangunk mountain in Ulster county and southwesterly into New Jersey, with an outlier near Cornwall, Orange county. The quarries near Otisville have supplied considerable quantities of stone for abutments and rough masonry.

The Clinton sandstone is mainly developed in central New York, being absent from the Clinton belt in the western part of the State. It forms ledges of considerable extent on the south side of the Mohawk valley from Ilion to Utica and beyond. It consists of reddish brown and gray sandstones, of medium texture and hardness. The stone has been used for foundations and building in Utica and other places in the vicinity.

Of the Devonian formations which cover about one-third the whole area of the State, the Hamilton, Portage, Chemung and Catskill contain important sandstone members serviceable for quarry operations. These sandstones are popularly known as blue-stones, a name first applied in Ulster county where they are distinguished by a bluish gray color. They are for the most part fine-grained, evenly bedded, bluish or gray sandstones, often showing a pronounced tendency to split along planes parallel to the bedding so as to yield smooth, thin slabs. For that reason they are extensively used for flag and curbstone, and a large industry is based on the quarrying of these materials for sale in the eastern cities. Most flagstone is produced in the region along the Hudson and Delaware rivers, where there are convenient shipping facilities to New York, Philadelphia and other large cities. The Hudson River district includes Albany, Greene and Ulster counties, but the quarries are mainly situated in the area that includes southern Greene and northern Ulster, with Catskill, Saugerties and Kingston as the chief shipping points. The Delaware River district includes Sullivan, Delaware and Broome counties; the shipping stations are along the Erie and Ontario and Western railroads. The sandstone of this section ranges from Hamilton to Catskill age. In the area to the west the quarries are confined to the Portage and Chemung groups, with the most important ones in the Portage. There are large, well-equipped quarries near Norwich, Chenango county, and Warsaw, Wyoming county, which produce building stone for the general market. Numerous small quarries are found in Otsego, Chemung, Tompkins, Tioga, Schuyler, Steuben, Yates, Allegany, Cattaraugus and Chautauqua counties.

Production of sandstone. Sandstone, by reason of its adaptability and its wide distribution, is extensively quarried in the State, ranking next to limestone in commercial importance. The larger part of the output is employed in street work in the form of curbstone, flagstone and paving blocks, but an important quantity is also used as building stone. It finds very little application as crushed stone on account of its platy fracture.

The Devonian sandstones, which are collectively known as bluestone, are more widely quarried than the other kind; this production is carried on throughout the southern part of the State by a large number of individuals and companies. With few exceptions, the quarries are small, giving employment to only two or three workmen each and having very little in the way of mechanical equipment. Such small enterprises are particularly characteristic of the Hudson River and Delaware River regions where much of the flagstone and curbstone is produced. Many of the quarries are worked intermittently by farmers in the off season of their usual occupation. The stone is hauled down the hillside to the railroad sidings or the river docks where it is purchased by middlemen who ship it to the eastern markets. The stone from the Hudson River district is mainly shipped by barges from Kingston and Saugerties. In the interior it is shipped by rail. A statistical canvass of such small enterprises is a matter of great difficulty and is likely to afford very unreliable results. Consequently, it has been the practice in the compilation of this report to secure the information so far as possible from dealers who purchase the stone for shipment to the large wholesalers and consumers in the cities.

The production of sandstone during the last two years is shown in the accompanying tables which give its distribution also among the leading districts.

The combined value of all the sandstone quarried in 1914 was \$1,056,990, against \$1,321,272 in 1913. The total is exclusive of any sandstone quarried by contractors for use on the State highway system, for which it is impossible to assign any accurate value.

Of the value given, a little more than one-half was returned by the quarry companies operating in the bluestone districts, in exact figures \$546,314. This indicated a marked decline of activity in these districts as compared with the preceding year when the output was valued at \$753,510. There has been a falling off in the bluestone industry for several years back, owing to the increasing use of cement and concrete in street work. The value of the flagstone and curbstone made from blue stone was \$337,488 against

\$503,607 in 1913. At the same time the output of building stone amounted to \$191,239 against \$227,645 in 1913.

Sandstone other than bluestone represented a value of \$510,676 as compared with \$567,762 in 1913, the decline being much smaller than in the bluestone trade. The largest item in the value was paving blocks which amounted to \$279,687, against \$239,389 in 1913. These were quarried almost entirely in Orleans county which also produced a large amount of curbstone; the entire quarry output of this county had a value of \$439,635 against \$467,636 in the preceding year.

An unusual number of quarries reported as inactive during the past year, especially in the bluestone district. In part this was due to the poor market for stone, the demand being very quiet throughout the year and the prices on a low basis. Another contributing factor was the putting into effect of the new workmen's compensation law which appeared so formidable to some mine and quarry operators that they preferred to go out of business than submit to its requirements.

Production of sandstone in 1913

DISTRICT	BUILD- ING STONE	CURBING AND FLAG- GING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
<i>Bluestone</i>						
Hudson river.....	\$5 977	\$238 724	.....	\$2 250	\$3 400	\$11 094
Delaware river.....	51 611	251 080	.....	250	3 029	.....
Chenango county.....	66 645	7 523	.....	.....	.....	817
Wyoming county.....	97 776	1 200	.....	180	1 138	.....
Other districts.....	5 636	5 080	.....	.....	100	.....
Total bluestone...	\$227 645	\$503 607	.....	\$2 680	\$7 667	\$11 911
<i>Sandstone</i>						
Orleans county.....	\$21 636	\$170 725	\$230 397	\$2 124	\$23 791	\$19 963
Other districts.....	36 364	8 652	8 992	41 463	4 655	.....
Total sandstone..	\$58 000	\$179 377	\$239 389	\$43 587	\$28 446	\$19 963
Combined total...	\$285 645	\$682 984	\$239 389	\$46 267	\$36 113	\$31 874

Production of sandstone in 1914

DISTRICT	BUILD- ING STONE	CURBING AND FLAG- GING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
<i>Bluestone</i>						
Hudson river.....	\$5 500	\$153 436	.....	.....	.....	\$1 559
Delaware river.....	20 196	177 200	.....	.....	\$1 425	9 865
Chenango county.....	69 255	5 812	.....	.....	960	2 337
Wyoming county.....	92 201	1 000	.....	\$48	1 393	.....
Other districts.....	4 087	40	.....	.....	.....	.....
Total bluestone...	\$191 239	\$337 488	.....	\$48	\$3 778	\$13 761
<i>Sandstone</i>						
Orleans county.....	\$15 926	\$147 970	\$266 775	.....	\$1 319	\$7 645
Other districts.....	10 343	4 764	12 912	\$36 095	6 927	.....
Total sandstone...	\$26 269	\$152 734	\$279 687	\$36 095	\$8 246	\$7 645
Combined total...	\$217 508	\$490 222	\$279 687	\$36 143	\$12 024	\$21 406

• TRAP

Trap is not a distinct rock type, but the name properly belongs to the fine-grained, dark-colored igneous rocks that occur in intrusive sheets and dikes. In mineral composition it differs from most of the igneous rocks that are classed in the trade as granite by the prevalence of the basic plagioclase feldspars and the higher percentages of the iron magnesia minerals, while it contains no quartz. Some of the so-called "black granites," however, are trap. The name is sometimes applied to fine-grained rocks of granitic or syenitic composition and sometimes even to rocks of sedimentary derivation, but such usage is misleading and indefensible.

The particular value of trap is due to its hardness and toughness. Its fine, compact, homogeneous texture gives it great wearing powers and it is eminently adapted for road metal and concrete of which heavy service is required. The principal product, therefore, is crushed stone. It has been used to some extent, also, as paving blocks, but these are rather difficult to prepare, since trap very seldom shows any capacity for parting comparable to the rift and grain structures of granites. As a building stone it finds very little application, probably on account of its somber color. The expense of cutting and dressing trap is also an obstacle to its employment for building or ornamental purposes.

The trap quarried in New York State is properly a diabase. Its mineral composition varies somewhat in the different occurrences,

but the main ingredients are plagioclase, feldspar and pyroxene, with more or less of amphibole, olivine, magnetite and sometimes biotite. The texture is characteristic, for the feldspar forms lath-shaped crystals which interlace and inclose the pyroxene and other ingredients in the meshes, and it is this firmly knit fabric which gives the stone the qualities of strength and toughness.

The largest occurrence of trap in New York is represented by the Palisades of the Hudson and the continuation of the same intrusion which extends southward through New Jersey onto Staten Island and is also encountered in the interior of Rockland county. The Palisades are the exposed edge of a sill or sheet of diabase that is intruded between shales and sandstones of Triassic age. The sheet is several hundred feet thick, in places nearly 1000 feet, and in general seems to follow the bedding planes of the sedimentary strata which dip to the west and northwest at an angle of from 5° to 15° . The outcrop is narrow, seldom over a mile, and in places is limited to a single steep escarpment. The principal quarries are near Nyack and Haverstraw at the base of the cliffs. Other quarries have been opened near Suffern, Rockland county, on an isolated intrusion, and also near Port Richmond, Staten Island, at the southern end of the Palisades sill.

Trap occurs in numerous places in the Adirondacks, but mostly as narrow dikes. It is especially common in Essex and Clinton counties where there are many thousands of dikes that range from a few inches to 20 or 30 feet thick. On the southern border of the region are a few dikes of notable size, such as that in the town of Greenfield, Saratoga county, and at Little Falls in the Mohawk valley. A quarry has been opened in the Greenfield occurrence for the supply of crushed stone.

The quarrying of trap along the face of the Palisades in Rockland county probably will soon be discontinued, as it is designed to purchase the quarry properties for the Palisades Interstate Park. The lands to be included within the park extend from the river line to the top of the Palisades. So far only the quarry of the Manhattan Trap Rock Co. has been taken over and closed, but negotiations are proceeding for the acquirement of the other quarries along the river front.

The future of the industry in this section is somewhat unsettled. It is not unlikely that new quarries may be opened on top of the ridge and in the interior of Rockland county, though the facilities for production and shipment in that section can scarcely be equal to those of the present localities.

Production of trap

MATERIAL	1913		1914	
	Cubic yards	Value	Cubic yards	Value
Crushed stone for roads	631 134	\$499 776	519 600	\$420 280
Crushed stone for other purposes	640 165	501 394	455 400	350 320
Total	1 271 299	\$1 001 170	975 000	\$770 600

The production of trap in 1914 was entirely by the quarries in the Palisades section of Rockland county, although in former years some has been produced in the Adirondack region. The statistics furnished by the companies show that the output was about 25 per cent, below the production of the preceding year, amounting to 975,000 cubic yards valued at \$770,600 against 1,271,299 cubic yards valued at \$1,001,170 in 1913.

TALC

The market for talc was depressed last year in sympathy with the general conditions and the slackening of demand in the paper trade which consumes the larger part of the local product. There is little reason for believing that the depression is anything but temporary, since the uses of talc have become firmly established, not only in paper manufacture but in many other industries, so that they are not likely to be displaced. On the other hand the market is likely to make considerable gains by reason of the curtailment in the supply of white clays which are employed in the coating of paper. These clays are largely imported, the shipments hitherto coming mainly from Germany, as they are not produced to any extent in this country. The ground talc from the Gouverneur district possesses a natural fiber which makes it specially valuable for use in paper; the material can be thoroughly incorporated with the vegetable fiber and adds strength to the latter. The talc is retained by the paper stock to a larger extent than is clay.

The Gouverneur talc district consists of a narrow belt, lying to the southeast and east of that village in the towns of Fowler and Edwards, in which the talc occurs in lenticular bodies arranged in series along the strike. The bodies dip uniformly toward the north-

west at angles of from 30° to 60° , so that they are all worked by underground methods. The wall rocks are limestone and schist of Precambrian age, a part of the Adirondack crystalline formations. The fibrous talc is an alteration product of tremolite which it resembles in physical development, but the scaly talc apparently is the result of deposition by underground waters. Altogether there are fully fifteen or twenty different deposits, some of which, however, are not profitable under present conditions, and others are being held in reserve. The number of operative mines in recent years has ranged from five to eight or nine. The mines are opened by inclined shafts sunk on the footwall with levels driven from either side at intervals of 100 feet or less. The mining is simple and inexpensive, the main cost of the prepared talc being incidental to the mill treatment which involves reduction by several stages the final grinding being done in ball and tube mills. The final grinding requires from two to five hours.

The producers of talc in this district include the Ontario Talc Co. with a mine and mill near Fullerville, the Uniform Fibrous Talc Co. at Talcville, and the International Pulp Co. with mines near Talcville and Sylvia lake and mills at Hailesboro near Gouverneur. The Standard Talc Co. has a mine near Talcville, which was once worked by the United States Talc Co., but the company made no output last year. The North Country Corporation has been engaged lately in the development of a new deposit near Sylvia lake, town of Fowler.

The Gouverneur district first became an important shipper of ground talc about 1880, when the output amounted to 4000 tons, but it was developed a few years before that date. The production since has been continuous and in the last 20 years has averaged about 60,000 tons. The total product since the beginning has amounted to over 1,600,000 tons, worth about \$14,000,000 at the average prices received at Gouverneur.

A deposit of talc near Natural Bridge has been worked for the last four years, and has supplied a considerable quantity of material which is sold in ground form. This deposit occurs in limestones, but in a separate area from the Gouverneur belt and has a quite different character. The talc lacks any definite structure, except that it shows a granular appearance in places, and is associated with other hydrated silicates of the serpentine and chlorite groups. It appears to be a contact deposit, lying near an intrusion of granite. An analysis of the material was given in the last previous issue of this report. The mine is operated by the St Lawrence Talc Co.,

Inc., the product being ground in a local mill which is equipped on the usual plan of the Gouverneur mills.

The production of both districts last year amounted to 74,075 short tons with a value of \$671,286. This represented a large increase, as the total for 1913 was 63,000 tons worth \$551,250. The prices were approximately the same as those received in the preceding year.

Production of talc in New York

YEAR	SHORT TONS	VALUE	YEAR	SHORT TONS	VALUE
1883.....	6 000	\$75 000	1899.....	54 655	\$438 150
1884.....	10 000	110 000	1900.....	63 500	499 500
1885.....	10 000	110 000	1901.....	62 200	483 600
1886.....	12 000	125 000	1902.....	71 100	615 350
1887.....	15 000	160 000	1903.....	60 230	421 600
1888.....	20 000	210 000	1904.....	65 000	455 000
1889.....	23 476	244 170	1905.....	67 000	519 250
1890.....	41 354	389 196	1906.....	64 200	541 600
1891.....	53 054	493 068	1907.....	59 000	501 500
1892.....	41 925	472 485	1908.....	70 739	697 390
1893.....	36 500	337 625	1909.....	50 000	450 000
1894.....	50 500	454 500	1910.....	65 000	552 500
1895.....	40 000	320 000	1911.....	65 000	552 500
1896.....	46 089	399 443	1912.....	61 619	511 437
1897.....	57 009	396 936	1913.....	63 000	551 250
1898.....	54 356	411 430	1914.....	74 075	671 286

ZINC

The zinc mine at Edwards, St Lawrence county, did not make any commercial shipments last year, but it produced a considerable quantity of ore in connection with the underground development that was continued from the previous season. This product is held for treatment by the new milling plant which was expected to be ready in the early part of 1915. The old mill was destroyed by fire after it had been remodeled and made ready for operations, and consequently shipments have been delayed beyond the period anticipated at the outset.

The general nature and occurrence of the zinc ores in this part of St Lawrence county have been described in previous issues of this report; no remarkable discoveries or new features have since come to light, and the main interest in the field at present centers upon the outcome of the single active enterprise which began the

development of the Edwards property several years ago. The results of the underground exploration, which has been carried on through two shafts, appear encouraging, as several thousands of tons of concentrating material carrying up to 40 per cent or more zinc have been uncovered. The product has been held in stock until it could be milled, as practically none of it is of shipping grade owing to admixture with pyrite. The first attempts in the separation of the minerals in which a special type of magnetic machine was employed did not prove a success. The ore was treated without previous roasting, as it was aimed to secure both the blende and the pyrite, the latter being in sufficient amount to make a valuable by-product if recoverable. The general run of the ore is fine-grained, and there is more or less serpentine and talc in the gangue, which may add to the difficulty of mill treatment.

The outcome of the present undertaking is naturally awaited with much interest; if successful it will mean a new industry in that section and will lead no doubt to other developments in the district.

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New York State Museum

JOHN M. CLARKE, Director

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1907. 212p. 63pl. <i>Not available.</i>	1913. 158p. il. 29pl. 40c.
1908. 234p. 39pl. map. <i>Not available.</i>	1914. 174p. il. 33pt. 45c.
1909. 230p. 41pl. 2 maps, 4 charts.	

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These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Geologist's annual reports 1881-date. Rep'ts 1, 3-13, 17-date, 8vo; 2, 14-16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899-1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837-41, are out of print.

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15, 2v.	2	19	.40	23	.45
16	1	20	.50	[See Director's annual reports]	

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See first note under Geologist's annual reports.

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5	.25	13	<i>Out of print</i>	23 (" 124)	.75
6	.15	14 (Bul. 23)	.20	24 (" 134)	.35
7	.20	15 (" 31)	.15	25 (" 141)	.35
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9	.25	18 (" 64)	.20	27 (" 155)	.40
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Botanist's annual reports 1867-date.

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Separate reports for 1871-74, 1876, 1888-98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), in volume 4 of the 56th (1902), in volume 2 of the 57th (1903), in volume 4 of the 58th (1904), in volume 2 of the 59th (1905), in volume 1 of the 60th (1906), in volume 2 of the 61st (1907), 62d (1908), 63d (1909), 64th (1910), 65th (1911) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum Memoir 4.

Museum bulletins 1887-date. 8vo. *To advance subscribers, \$2 a year, or \$1 a year for division* (1) *geology, economic geology, paleontology, mineralogy;* 50c *each for division* (2) *general zoology, archeology, miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are grouped in the list on the following pages according to divisions.

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Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. 8vo. 1853. *Out of print.*

Handbooks 1893–date.

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Outlines, history and work of the museum with list of staff 1902.

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Geologic maps. Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum Bulletin 15 and 48th Museum Report, v. 1. 59 x 67 cm. 1894. Scale 14 miles to 1 inch. 15c.

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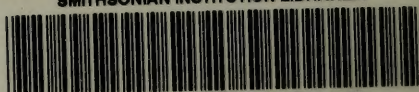








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